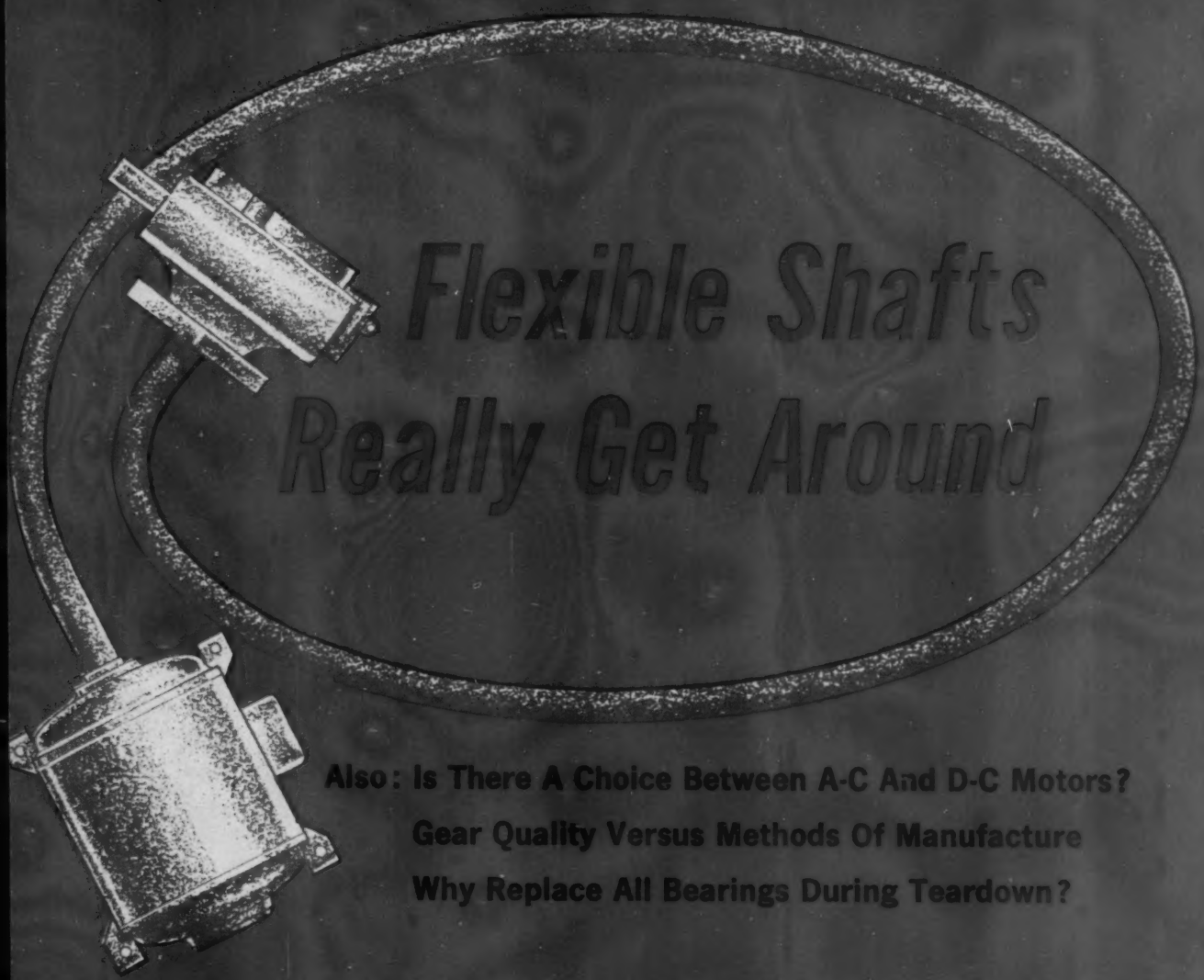
POWER TRANSMISSION DESIGN

JUNE 1959

OEM · MAINTENANCE



Flexible Shafts Really Get Around

Also: Is There A Choice Between A-C And D-C Motors?
Gear Quality Versus Methods Of Manufacture
Why Replace All Bearings During Teardown?

THE MAGAZINE OF MACHINE DRIVES

News and ideas for designers and plant engineers who use power drive equipment

Announcing Worthington QD Sheaves with the

GOLDEN SCREWS

To demonstrate to you that the exclusive two-screw design is practically worth its weight in gold, all Worthington QD (Quick Detachable) sheaves now have two golden screws.

The clamp screw simplifies installation and assures permanent alignment. You can install QD sheaves one part at a time. No heavy rim and hub combination to delicately inch into place. You just slide the hub on the shaft and permanently lock it in position with the clamp screw. Then you slide the sheave rim into position on the hub. This job is simplified because you engage the large end of the sheave with the small end of the hub. To change speed you simply install another sheave on the hub which remains anchored to the shaft by the clamp screw.

The set screw prevents "key drift." It locks the key securely in place, avoiding the danger of the key drifting off and becoming a safety hazard. This feature is appreciated by plant operators who first brought this potential danger to Worthington's attention.

You tighten the set screw without distorting the hub. The clamp screw allows you to locate the hub on the shaft. The locked hub then permits you to tighten set screw on key without distortion.

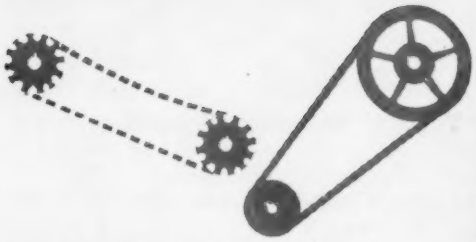
You can get Worthington QD sheaves anywhere in the U.S. More than 350 distributors carry Worthington sheaves and Worthington-Goodyear Green Seal V-belts. For your copy of a 100-page Multi-V-Drive Manual on how to select the right sheave and V-belt write to Worthington Corporation, Section 79-15, Oil City, Pennsylvania. In Canada: Worthington (Canada) Ltd., Brantford, Ontario.

WORTHINGTON

For more information circle No. 28 on the Reader Service Card

maurey DRIVES

make productive machines



Maurey V-Drives and Roller Chain Drives upgrade a machine three important ways:

PRODUCTION-wise
They drive the full power of the motor into your machine's productive "muscles."

DESIGN-wise
They conserve space for modern trimness.

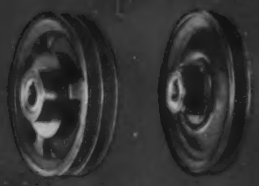
MAINTENANCE-wise
They make repairs and replacements, when necessary, simple, quick and low in cost.

Why not give your machine the production lift and the modern look that a Maurey Drive assures? A Maurey power transmission specialist will be glad to help with your drive plans, at no obligation. And you can depend on Maurey delivery to keep your production on schedule.

Call your local Maurey Drive distributor, or write for any one or all of these Maurey Power Transmission Catalogs:

- FHP V-Drive Catalog F-10
- V-Belt Catalog No. 55
- Multiple V-Drive Catalog, MVD-58
- Maureymatic Variable Speed Transmission Catalog No. MM-58
- V-Drive Engineering Manual
- Roller Chain Drive Catalog D-58
- Conveyor Pulley Catalog CV-1

the complete, *engineered* drive line

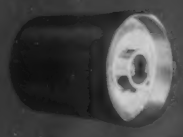


Hi-Q FHP V-Pulleys

FUL-GRIP Q-D Sheaves

Mor-Grip Green Seal V-Belts

Maureymatic
Variable Speed Transmissions



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READERS' GUIDE

June 1959, *volume 1 number 6*

FEATURE SECTION

IDEAS FOR DESIGNERS AND PLANT ENGINEERS

BEARING SECTION

REFERENCE FILE

ABSTRACTS

DEPARTMENTS

FACTS

and figures on products and literature of interest to designers, engineers, and other power transmission design people can be had by circling the right numbers on the reader service cards found opposite page 64.

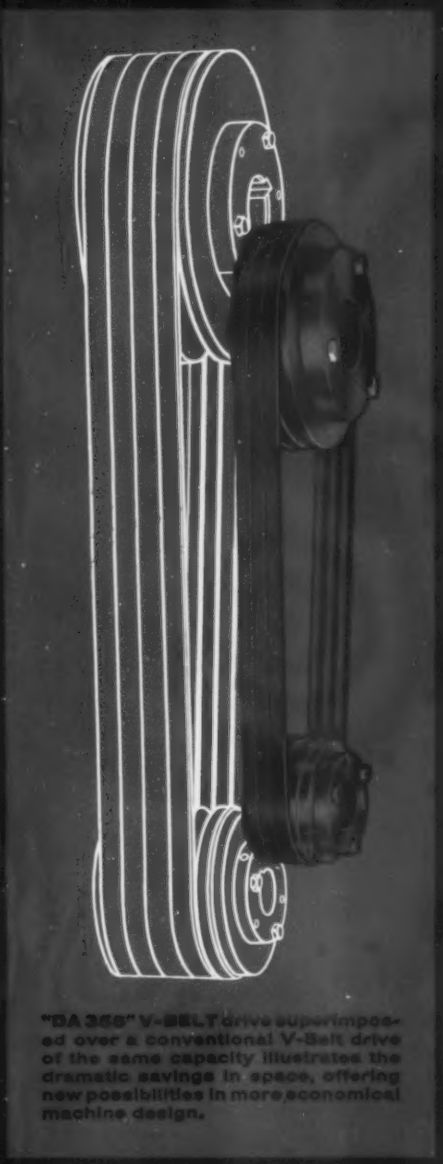
Now . . . from Durkee-Atwood

DA 358 V-BELTS

Introducing the entirely new V-Belt concept for compact, Plus-Power Drives

From Durkee-Atwood, pioneer manufacturer of high quality V-Belts for industry, comes the great new "DA 358" V-Belt, opening up completely new opportunities for highly compact, economical multiple V-Belt drives. "DA 358" V-Belts are engineered for unprecedented power transmission as compared with conventional V-Belts . . . with the ability to transmit more horsepower in a given area, at less cost, and with fewer belts, smaller, lighter sheaves and shorter center distances. They are manufactured with the quality and precision for which Durkee-Atwood is famous—quality which *we invite you to test.* Manufactured in 3V, 5V and 8V sizes.

SPECIAL: Durkee-Atwood's new "Red Shield" V-Belts now have a ***horsepower rating 40 per cent higher than former Standard V-Belts***—part of a major V-Belt upgrading program for improved drive design.



"DA 358" V-BELT drive superimposed over a conventional V-Belt drive of the same capacity illustrates the dramatic savings in space, offering new possibilities in more economical machine design.

We invite you to test DA 358 V-Belt against all other V-Belts

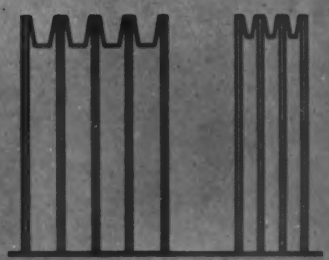
Write on your letterhead giving data, and we will forward to you our engineering recommendations.

Write

DURKEE-ATWOOD COMPANY

MINNEAPOLIS 13, MINNESOTA

Look for the DA DURKEE ATWOOD SINCE 1910 *on your V-Belts*



SHEAVE WIDTHS are sharply reduced with a "DA 358" V-Belt drive. Figure at left shows sheave width for a conventional drive. Figure at right is sheave width for a comparable "DA 358" V-Belt drive.

For more information circle No. 11 on the Reader Service Card

MEN *of the power transmission industry*

Chamberlain heads AMF division

CHAMBERLAIN

NEW YORK, N. Y.—William E. Chamberlain, Jr. has been appointed divisional vice president of American Machine & Foundry Company, Morehead Patterson, AMF board chairman, has announced.

Mr. Chamberlain will continue to serve as assistant group executive of AMF's Atomic Energy group and as general manager of the Atomics division. In addition to his position with AMF, Mr. Chamberlain is general manager of Industrial Reactor Laboratories, Inc., a cooperative industrial nuclear research center owned by ten of the nation's leading industrial firms.

The new vice president has had eighteen years' engineering experience in industry, including aircraft engine design, electronic communications and weapons systems, submarine design, and nuclear research.

MacLean succeeds Otis at Dodge

MISHAWAKA, IND.—J. Allen MacLean became president of Dodge Manufacturing Corporation, Mishawaka, Ind., on June 1. He succeeded Joseph E. Otis, Jr., who on the same date became chairman of the corporation's board of directors.

Mr. MacLean joins Dodge, a leading manufacturer of power transmission machinery since 1878, from Bendix Aviation Corporation, South Bend, where he was group executive and general manager of Bendix Products Division. Mr. Otis served as president of Dodge from 1939, having previously been president of Stewart-Warner Corporation, Chicago.

MacLean, who is 47, has been a member of the Dodge board of directors since 1956. Prior to his association with Bendix, he taught mechanical and aeronautical engineering at the Universities of Notre Dame and North Carolina.

MACLEAN

New Bunting research chief

Bunting Brass & Bronze Co. now has a Research and Development Dept. with Dr. Ralph A. Schaefer as its director.

HALEY

Durkee-Atwood names vp

MINNEAPOLIS, MINN.—Carter Haley is the new vice-president in charge of industrial division sales of the Durkee-Atwood Co., Minneapolis. Announcement of the promotion was made by E. P. Atwood, company president.

With Durkee-Atwood for nine years, Mr. Haley was most recently sales manager of the industrial division, which makes automotive fan belts and V-belts among other products.

Crumpler named sales engineer at Franklin Electric

BLUFFTON, IND.—Seymour S. Crumpler has been named sales engineer of Franklin Electric Co., Inc., according to an announcement by A. C. BeVier, vice president for marketing. Mr. Crumpler will represent the company in Georgia, Florida, Alabama, North and South Carolina.

Mr. Crumpler has served the company as sales engineer in the Indiana territory. He was previously associated with the New Departure Division of General Motors. He will headquarter in Atlanta, Georgia, and will represent Franklin Electric's complete line of application engineered motors in the Southern area.

Continued on page 45

POWER TRANSMISSION DESIGN

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DAVID R. CARTWRIGHT .....editor
KEITH A. CARLSON ....managing editor
DAVID JENNESS .....assistant editor
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HENRY LEFER .....eastern editor
SCHOLER BANGS .....western editor
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ALARIC MAUSSER .....art director
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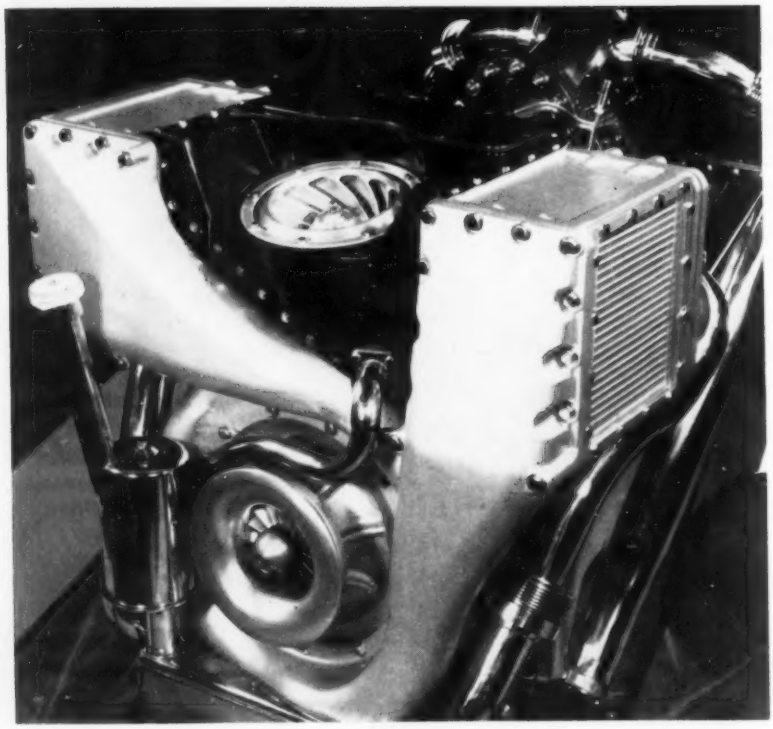
AFFILIATED PUBLICATIONS: Applied Hydraulics & Pneumatics, Industry & Welding, Material Handling Engineering (formerly Flow), Material Handling Illustrated, Modern Office Procedures, Occupational Hazards, Precision Metal Molding, The Refrigeration & Air-Conditioning Business, Welding Illustrated. Accepted as a controlled circulation publication at Pontiac, Illinois. Return form 3579 to 812 Huron Rd., Cleveland 15, Ohio.

NEWS *from the power transmission field*



EXTERIOR VIEW of Ford Motor Company's new supercharged gas turbine engine.

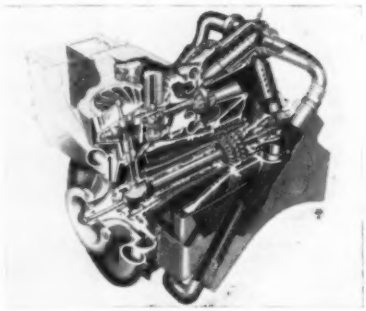
1959 to see test of Ford's new 704

DEARBORN, MICH.—"The Ford 704 represents an important breakthrough in gas turbine design technology," B. T. Howes, associate director of Engineering Research and Advanced Product Study, said in announcing the new engine.

Weight of the 300 hp turbine is only one-fourth that of a truck diesel engine of comparable horsepower, while its fuel economy rivals a diesel's and is superior to conventional gasoline engines, under most operating conditions.

Earlier turbine engines were efficient only at full power operation. The 704, Mr. Howes said, "attains maximum fuel economy in a range of 25 to 100 per cent of power." Another innovation is two stages of air compression, one a supercharging stage, enabling the engine to deliver more horsepower from a smaller size.

The Ford 704 is planned for any application requiring about 300 horsepower and good fuel economy over a wide operating range. Possible uses might be for cars and trucks, tanks, tractors and bulldozers, off-road vehicles, auxiliary or stand-by power generators, starter carts for jet aircraft and even small locomotives. A wide variety of fuels may be used—unleaded gasoline, kerosene, jet engine fuel or light diesel fuel—and no warm-up period is required.



The 704 weight 650 pounds, requiring only the addition of electrical power and fuel. A diesel truck engine of approximately 300 horsepower weighs about 2,700 pounds. The package size is 38 inches long, 29 inches wide and 28 inches high—small enough, for example, to fit easily into the engine compartments of standard cars.

Developed over two and a half years, the turbine was shown to the Defense Department last month. Ford expects to test it in vehicles before the end of the year.

Each compression stage has a four-to-one compression ratio. The low-speed compressor turns at 46,500 revolutions per minute and the high-speed at 91,500. Both the primary and re-heat secondary combustion chambers operate at 1,700 degrees Fahrenheit. Exhaust gases are discharged at about 740 degrees F., or roughly the same temperature as conventional car engine exhausts. Power turbine is driven at 36,000 rpm. Turbine shaft, through a step-down gear arrangement, turns the drive shaft at 4,600 rpm at full power.

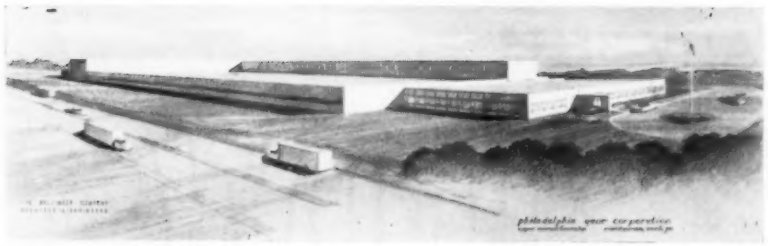
MacDonald chairman of N.E.W. week

NEW YORK, N. Y.—N. J. MacDonald, president of The Thomas & Betts Co., Elizabeth, N. J., will serve as chairman of the 1960 National Electrical Week.

Mr. MacDonald was elected at the annual meeting of the N. E. W. Industry Committee. Other officers of the Week are R. M. Johannesen, Johannesen Electric Co., vice chairman; H. A. Webster, T. Frederick Jackson, Inc., treasurer; and A. W. Hooper, executive director of the National Association of Electrical Distributors, secretary.

The 1960 Week will be observed Feb. 7-13 to coincide with the anniversary of Thomas A. Edison's birth.

Other news from the National Electrical Manufacturers Association includes the establishing of a standing Public Relations Committee with liaison functions among association subgroups and allied customer organizations.



Philadelphia Gear builds new plant

PHILADELPHIA, PA.—The Philadelphia Gear Corp. recently began construction of a new manufacturing plant at King of Prussia, Pa. The new plant will replace the company's smaller facilities now located in Philadelphia.

The new plant is designed specially for the manufacture of precision gear products. Large areas of the factory are to be air-conditioned to ensure precise tolerances and protect against temperature changes. With the building program, the company is currently installing new, extremely accurate gear grinding equipment for gearing in high speed drives, radar scanning equipment, marine propulsion and other power transmission fields requiring more than average accuracy.

Completion of the 180,000 square foot building is due late this year, with full operation in 1960.

Southwest Products expands

MONROVIA, CALIF.—A new, two-story industrial office building of 7500 square feet is now under construction for Southwest Products Co., Monrovia, Calif., according to K. V. Hackman, president and general manager.

The building will house the engineering, research and development departments of the company. An attached cantilevered steel deck of 1020 square feet will provide recreation facilities for employees.

Completely air-conditioned, the building will have acoustical control throughout and high level fluorescent lighting of latest design.

Southwest Products manufactures "Monoball" self-aligning bearings, "Flexible" mechanical push-pull controls, and "Flexhot" air duct joints, and serves the aircraft industry in the far west.

Electronic device analyzes bearings

HUNTINGTON PARK, CALIF.—Bearing Inspection, Inc., Huntington Park, Calif., has introduced a new, completely electronic instrument designed specifically to analyze the quality of anti-friction bearings.

The analyzer identifies unserviceable bearings by both visual and audible means. Rejection of a bearing by the instrument is indicated by a red light, making possible operation even by unskilled workers. Complete check of balls or rollers and all raceways is achieved in one-half to two minutes, according to the company.

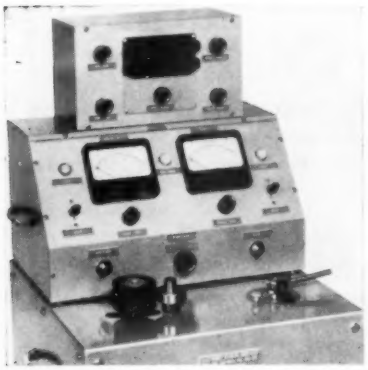
The user can set his own quality standards, or a standard rejection limit can be built into the instrument at the plant.

Liquid-fueled engine propels Discoverer

VANDENBERG AIR FORCE BASE, CALIF.—The Discoverer II satellite, which was successfully launched and put into orbit in late April, was powered by a liquid-fueled rocket engine developed by Bell Aircraft Corp., Buffalo, N. Y.

Bell's Space Flight Division provided the 15,000 pound thrust engine under sub-contract to the Lockheed Missiles and Space Division, prime contractor and system manager for the Air Force Discoverer series. Lockheed designed and built the satellite that was used in the test.

The Bell engine was fueled with unsymmetrical-dimethylhydrazine (UDMH) using red fuming nitric acid as the oxidizer. According to the Bell laboratories, the engine represented the highest possible performance for any rocket engine in its thrust range. In fifteen years of research and development in the field of rocketry, nearly one hundred different propellants have been evaluated in Bell's laboratories, and thousands of test runs have been made in more than fifty test cells. The first version of the engine used in Discoverer II had, at the time of launching, undergone flight rating tests for a space power plant and other more advanced space programs.



Finishing method improves gear teeth

DETROIT, MICH.—A new method enables manufacturers of spur and helical gears to economically apply the gear tooth honing process to gears in the 12 to 200 inch diameter range. The method is a development of the National Broach & Machine Co., Detroit, Mich.

Separate tool heads and feeding mechanisms make it possible for one large rotary machine to perform both the gear tooth shaving and the gear tooth honing operations.

Gears in these diameter ranges are usually produced in small quantities By developing one machine to do both types of tooth finishing, important economies are achieved.

Red Ring honing is now in use by the automotive, aircraft, electric motor and materials handling industries.

LETTERS

Address letters to:
The Editor
Power Transmission Design
812 Huron Road, Cleveland 15, Ohio

Gentlemen:

We believe your publication to be a real "boon" to the Original Equipment Market and are considering subscriptions for our sales group who contact this field. If possible, we would like the May issue sent to us so that we may forward copies to the field for collective evaluation.

J. H. KEARNS
Gates Rubber of Canada, Ltd.
Brantford, Ontario

Gentlemen:

Congratulations—POWER TRANSMISSION DESIGN is the best yet. Our engineering and design department welcome the brief and practical scope. Keep them all that way.

R. C. WEBB
Chief Design Engineer
Ferguson Door Co.
Los Angeles, Calif.

Gentlemen:

We are pleased with the first four issues of POWER TRANSMISSION DESIGN . . . The feature that has received much comment is the perforation of the sheets. We believe you are doing a good job of varying the subjects in the articles and in this way you are "getting to" everyone. We like your *Ideas* section which we can refer to for possible assistance with problems. Your *Men* department is very good too, as we are able to keep tabs on many of these personalities known to us. All in all we think you are doing a fine job and we hope you are able to continue at the present standard.

R. G. WILLIAMS
Vice President
Industrial Transmission, Inc.
Buffalo, N. Y.

EDITOR'S PAGE

David R. Cartwright
editor

STARTING WITH THIS ISSUE . . .

. . . you can get more information on any of the components discussed in the editorial articles in this issue.

This means that if you want more details or exact specifications about any component, small as it might be, mentioned anywhere in an article, we can supply you with the information.

On page 57 are blanks to be filled out for this. Mail them in and we'll send you general specifications about that particular product, name and address of the manufacturer.

We hope this added information will better serve you in your work.

Here's what the blanks on page 57 look like.

(*Sample blank*)

EDITOR, POWER TRANSMISSION DESIGN *JUNE, 1959*
812 HURON ROAD, CLEVELAND 15, OHIO

Please send me more information on components discussed in articles below. I am listing only one component per line.

(1) ..... (Component Name) on page ..... in Article No. .....

(2) ..... (Component Name) on page ..... in Article No. .....

(3) ..... (Component Name) on page ..... in Article No. .....

(4) ..... (Component Name) on page ..... in Article No. .....

NAME .....POSITION .....

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Dave Cartwright

Editor

the most important advance in couplings since Sier-Bath's flangeless design!

new nyflex

Flexible Gear Couplings WITH NYLON SLEEVES

- No lubrication required
- Takes more misalignment than standard gear couplings
- Top performance in horizontal or vertical positions
- Weighs only 3½ pounds
- Low in price
- Speeds to 5000 rpm
- 1⅝" max. shaft capacity

ONLY 5 PARTS

Assembles, disassembles in seconds, no special tools needed!

This NYFLEX flexible gear coupling has a one-piece sleeve weighing only four ounces! The entire assembly, including high-strength steel hubs and retaining rings, weighs just 3½ pounds. It's the lightest, most compact flexible gear coupling you can buy. Another outstanding "first" from Sier-Bath, pioneer producer of flangeless, one-piece flexible gear couplings.

The NYFLEX coupling gives you several innovations in design and performance. It never needs lubrication . . . Takes almost 5° misalignment . . . Can be run equally well in either horizontal or vertical installations . . . Operating temperatures may be as high as 150°F . . Wide range of horsepower capacities and shaft speeds to 5000 rpm. And it's priced as low as *half the cost* of comparable all-steel couplings! Ten bore sizes available NOW from stock.

Bulletin N-1 gives the complete story of the new Sier-Bath Nyflex coupling. It's yours for the asking.

Sier-Bath

Founded 1905 Member A.G.M.A.

GEAR AND PUMP COMPANY, INC.
9252 Hudson Blvd., North Bergen, N. J.

For more information circle No. 23 on the Reader Service Card

Choose your gears by how well they're made

BY HARRY PELPHREY, *Director of Research, Michigan Tool Co.*

There are 17 conventional ways of making and finishing gears and splines. Some remove material, such as hobbing, broaching, milling, shaping, grinding, punching, shaving and shear cutting. Others cast metal, such as pouring hot metal, sintering and injection molding. The remaining form metal, such as cold drawing, thread rolling and forging.

Gear teeth are either generated, form cut, die formed or press formed. Generating means that the tools form the desired tooth shape, such as hobbing, shaping, roll forming, shaving, burnishing, grinding, abrading and lapping. Form cutting includes milling, shear cutting, broaching and grinding. Die forming includes injection molding, forging, roll forming, casting, drawing and sintering. Press forming includes punching.

All operations are classified as either roughing, semi-finishing or finishing. Some are done before heat treat, others after. Of all mentioned, there are other variations that intermix the categories.

When you specify gears, you get only what you ask for. Besides quality, you also get imperfections inherent with that method of manufacture. To help you, let's discuss each:

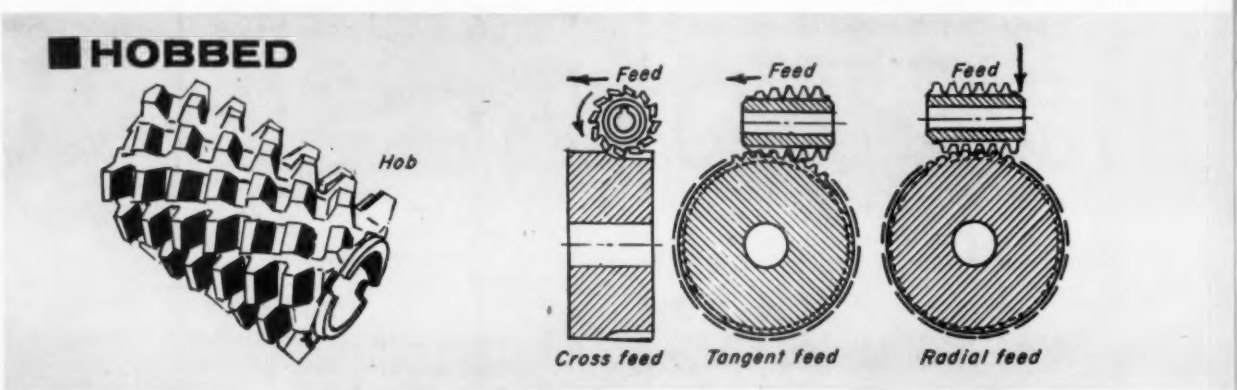
Hobbed

Hobbing is done with a special cutter feeding against the gear blank. Cutting edges of the tool produce the tooth form directly. Tooth form, however, is unlike the individual form of the cutting edges.

As the hob feeds across the work, continuous indexing and feeding of the teeth cut the gear. Each successive tooth removes a small chip. Cutting is continuous. There are two types of feed used: conventional and climb. The climb cut is now the most common used.

Shaved

Shaving is a finishing operation. Compared with grinding, it is faster. It is used as a corrective operation generally up to 38 Rockwell C, but generally at much lower hardness. There are two types of cutters: rotary and rack. Rotary cutter has teeth with profiles like that of a gear. As the cutter rotates, the notches scrape off little shavings. The rack cutter has serrated teeth. The gear to be shaved is rolled back and forth over the cutter.



Shaped

This method uses a cutter which is a hardened gear with relieved teeth. The cutter and gear are mounted on parallel axes. The cutter reciprocates up and down and is fed progressively into the blank. They revolve as a gear pair. As they revolve, the cutter generates teeth all around the blank. The cutter moves away from the blank and returns each stroke; cutter operation is fast at many hundred strokes a minute.

Milled

Types of milling cutters are many. Profile cutters cut the tooth profile. Plain cutters have a cylindrical shape with teeth on the circumference. Side cutters have teeth on both the circumference and sides. Other cutters are shank or arbor-type with cutting edges on one or more angular surfaces.

Broached

A broaching tool removes material by shaping a hole in a gear blank. The cutter is a long bar with a series of cutting edges which increase in size from one end to the other. It is either pushed or pulled through the hole and, because of the progressively higher cutting edges, each tooth removes an additional amount of material. Generally an internal operation.

Shear Cut

This is to be compared with internal broaching. The cutter consists of four parts; a housing; a slotted member that holds the cutting tools; a cone shaped guide that feeds the tools inward; and the tools that do the cutting. The work is moved up and down inside the assembly while the tools feed progressively inward or outward during each stroke, for O D. or I. D. cutting.

Ground

An operation usually performed after a semi-finished gear has been heat treated to a high hardness and has had side reference surfaces previously finished. There are chiefly two types of grinding: form and generating. Form grinding uses a disc wheel to grind both sides of the space between the gear teeth. Action

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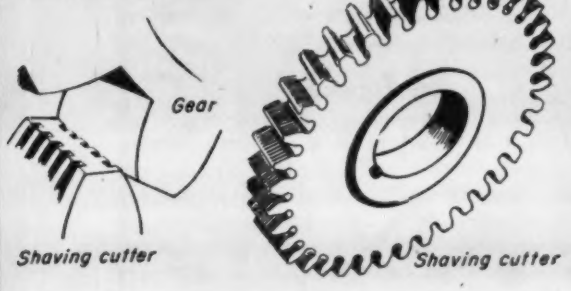
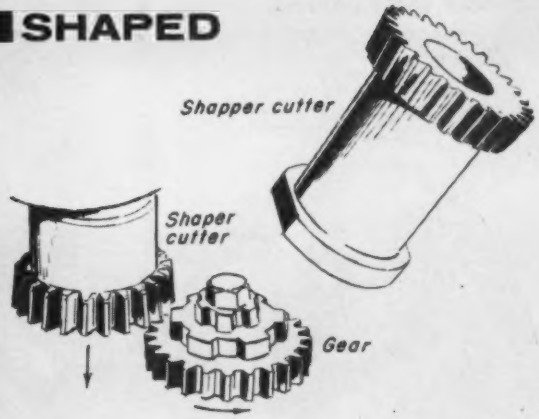
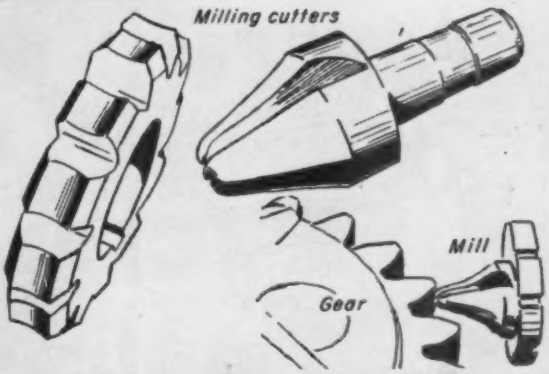
SHAVED



SHAPED



MILLED



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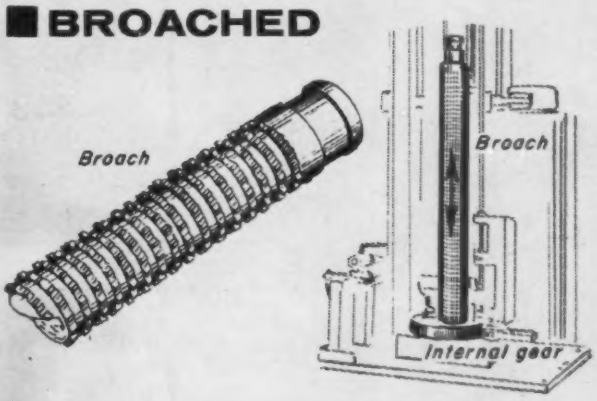
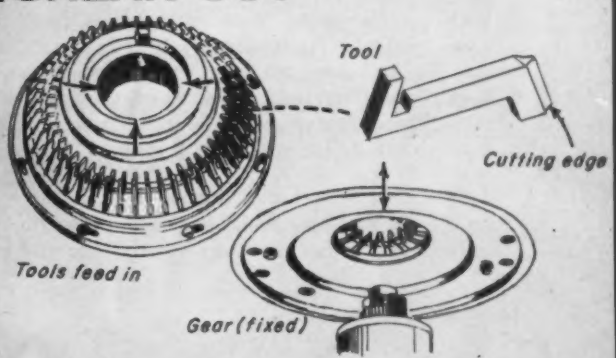
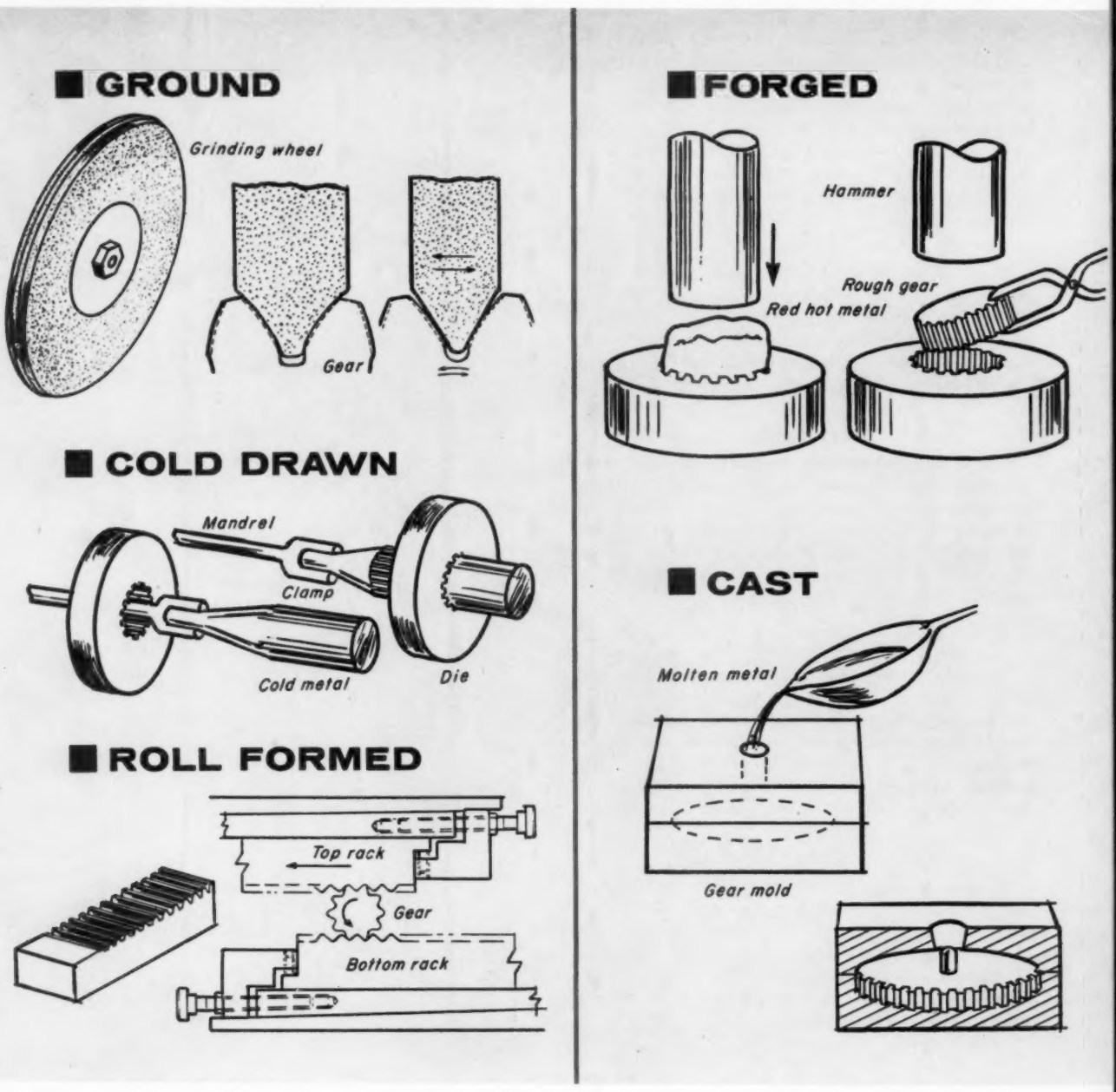


SHEAR CUT





is similar to that of a milling cutter, back and forth. The wheels have an involute form in their sides. Generating grinding is done with a disc or threaded wheel. With the disc wheel, three motions are used. The wheel rotates as the spindle is moved back and forth over the work; and the wheel moves sideways as the work rotates. With the threaded wheel, action is similar to hobbing. Several roughing cuts bring the gear down to size; finishing cuts clean it up.

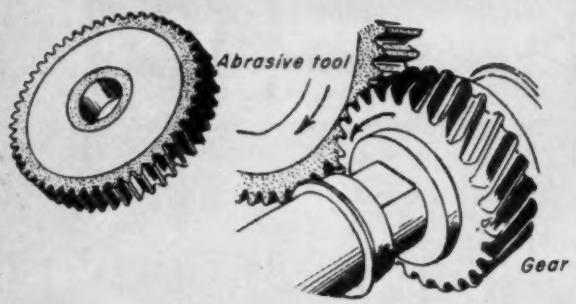
Cold drawn

Gear stock in long round lengths is pulled through a die which draws the outer surface into the gear shape. Short pinions are easily cut-off. The pinion may be drilled before or after cut-off for the mounting hole. Extruded gears came under this category.

Roll Formed

This is also a hot or cold working process in which a metal shaft is placed between oppositely moving racks that press the teeth into shape from zero shape to maximum depth during one pass. It is particularly adaptable to axles, drive shafts and other work on which the gear is on one end. However, centerless roll forming is done where the blank is held on an adapter during the pass through the racks.

ABRADED



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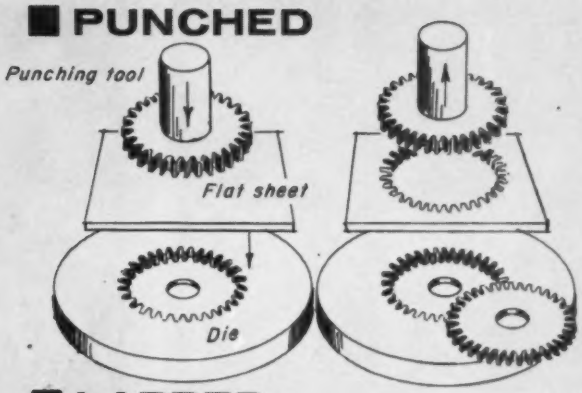

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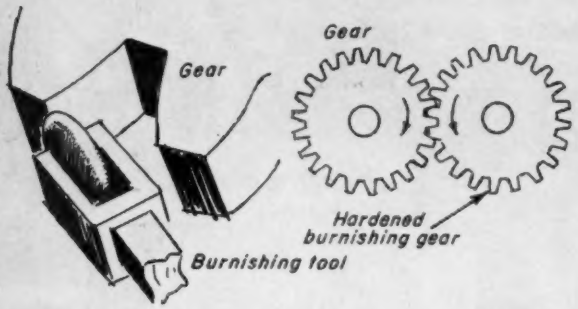
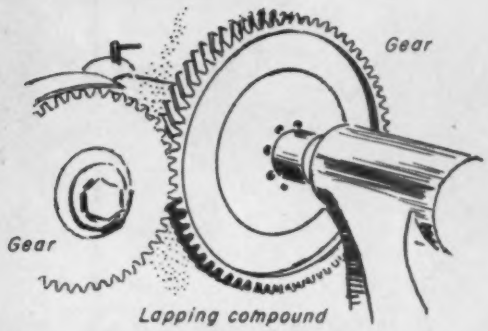
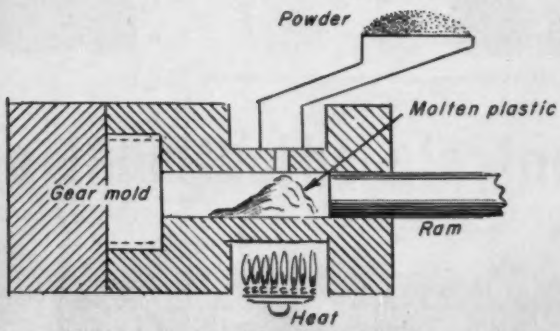


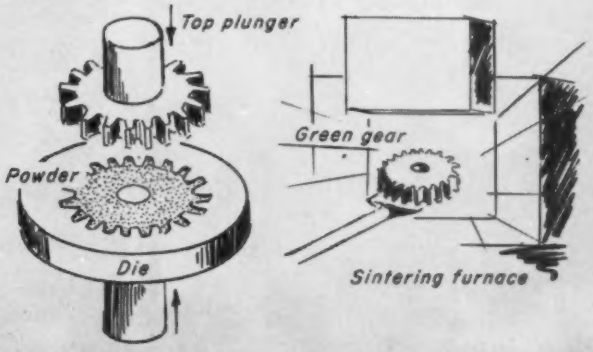
LAPPED



INJECTION MOLDED



SINTERED



Forged

This is a roughing operation for high-strength gears in which hot metal is hammered between tools into the general shape of the final gear. Great strength is achieved by the arrangement of the grain structure.

Cast

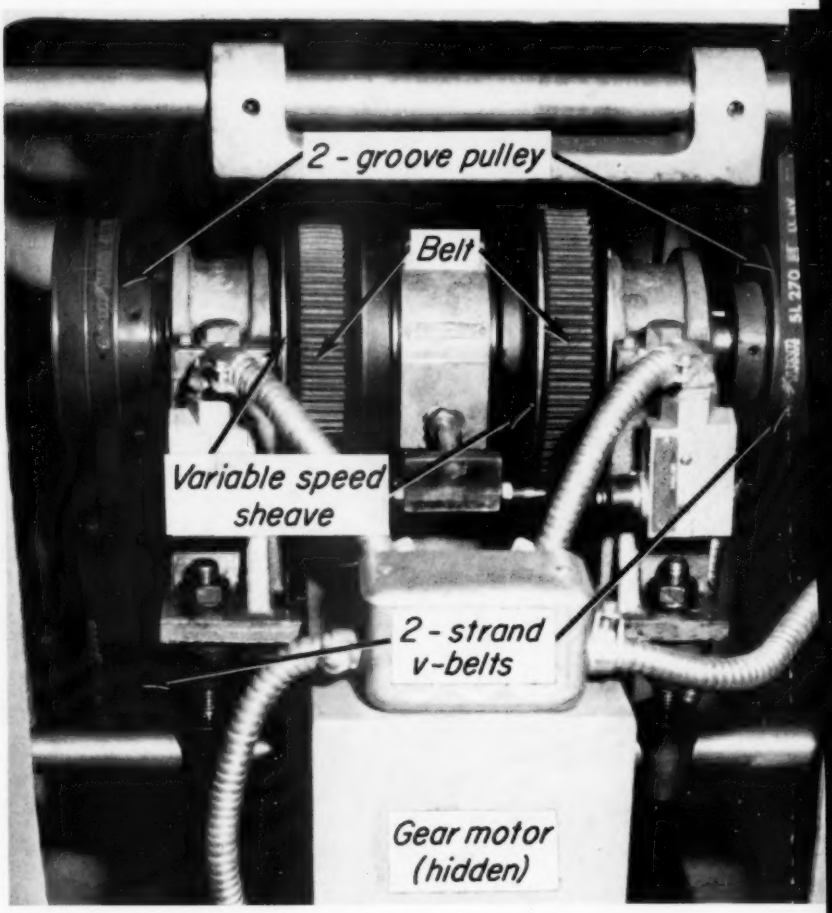
This is a fast method in which hot metal is poured into a mold that has the gear shape. There are many types of casting operations including investment, die, sand, frozen mercury and others.

Abraded

Abrasive gearlike tools are used to improve tooth form by removing burrs, nicks, and projections. It is unlike grinding or lapping, as the surface speed of the abrasive wheel is about $\frac{1}{8}$ the speed of grinding. Virtually no heat is generated. The axis of the abrasive tool is set up at an angle to the work axis. Slippage occurs between the tool and tooth surfaces which provides the desired abrasive action.

Continued on page 55

GEARMOTOR with chain and sprocket.



VARIABLE PITCH SHEAVES transmit power at set speeds

Push-button control of a new lathe is achieved by eliminating manual operation of the variable speed drive. Here's how a . . .

Gearmotor controls adjustment of

By JOHN E. KNOX, *plant superintendent, Sheldon Machine Co., Inc.*

A GEARMOTOR controls spindle speed by changing adjustment of variable pitch sheaves on a new lathe. Adjustment of the sheaves is used to change speed in either forward or reverse directions. The result is a completely automatic pushbutton speed control.

With the four variable-pitch sheaves, spindle speeds can be adjusted to faster or slower speed by the machine's operator as needed. This gives him much more versatility than offered by other methods.

The gearmotor actuates the sheaves through a chain and sprocket drive. Two problems are solved:

(1) Getting an a-c mechanical pushbutton speed control.

(2) Providing a positive a-c drive which is a fast, convenient way of activating the variable pitch sheaves.

The gearmotor responds to short or long signals from the operator, and drives a sprocket at 1½ rpm. This sprocket drives a chain, which in turn drives a second sprocket at ¾-rpm.

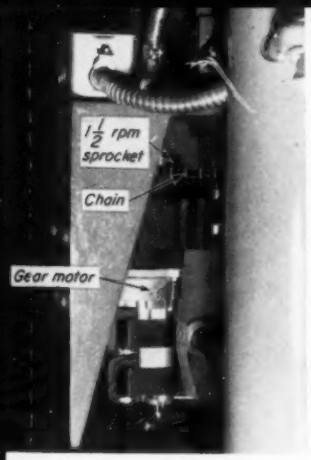
The slower sprocket is mounted directly on a shaft which turns a cam-roller, thus raising a cam bar and jackshaft assembly.

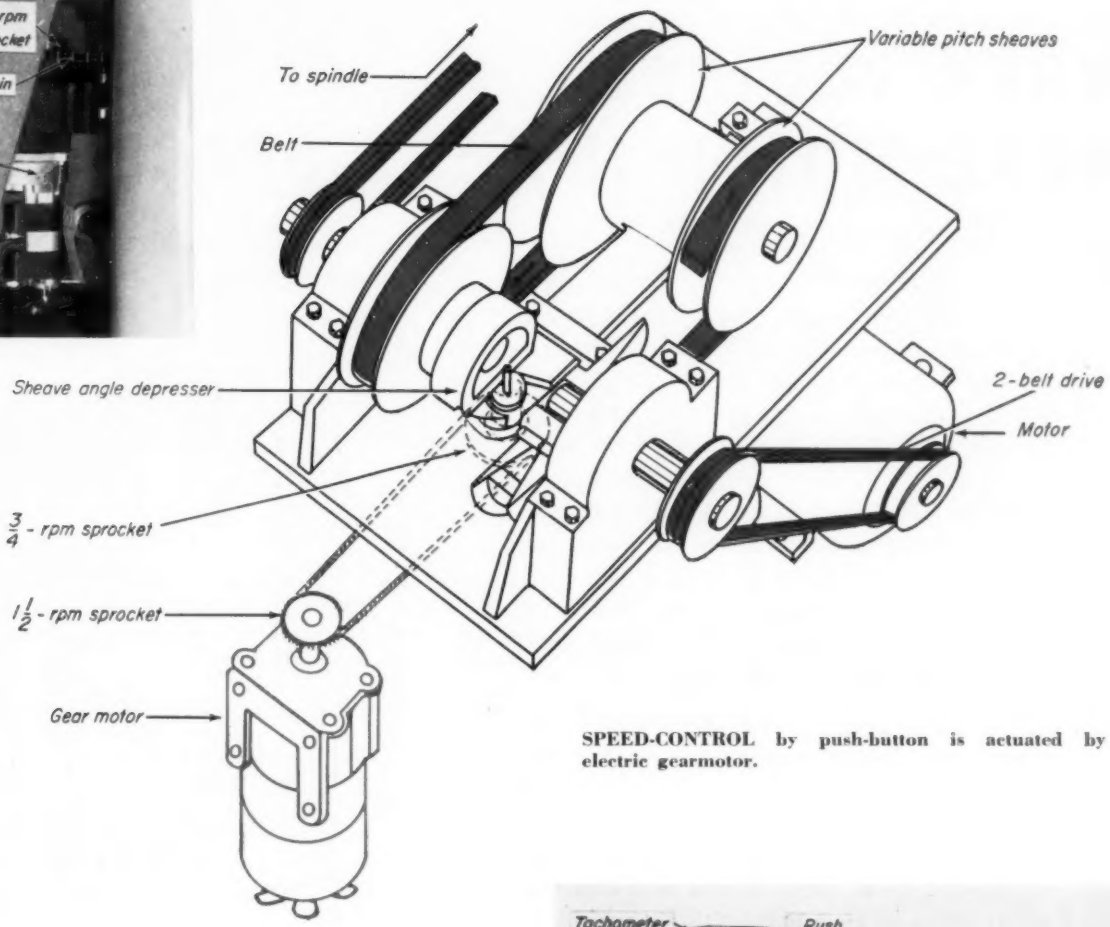
This is the final action which gives the operator complete control over minute changes in the belt-center distances on the variable pitch pulleys.

By controlling the cam bar, he can maintain tension as it is needed. This bar rides on the cam roller which is part of the control unit assembly. Actual rpm's of the spindle are picked up by a tachometer-generator.

Early in the development of the speed control mechanism, direct drive gears were considered instead of the chain and sprocket. But tests showed they would not work. There were too many alignment problems.

No. 1. For more information on any component in this article, see page 57





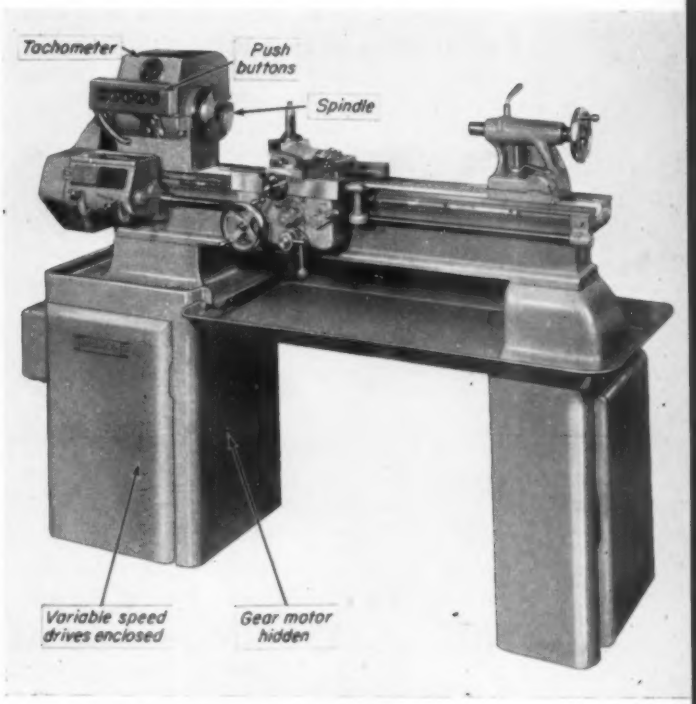
SPEED-CONTROL by push-button is actuated by electric gearmotor.

variable-pitch sheaves

The main motor drive of the lathe is 2-hp which puts 1800 rpm into the variable speed drive. Shafts, on which the variable pitch sheaves are mounted, are driven by double V-belts.

After the operator has set and selected his preferred speed, power is delivered to the lathe's spindle by means of the second double V-belt drive seen at top-left in the above drawing. This drives a 2-groove sheave that powers a standard lathe backgear unit. Using the gearmotor and avoiding the application of d-c speed control sidestepped many electrical circuitry problems. The gearmotor's a-c electrical circuit eliminates need of d-c throughout the lathe.

Installing special d-c rectifiers and lines would only add to manufacturing and maintenance difficulties. In fact, pushbutton speed control would probably not be practical in any other way.

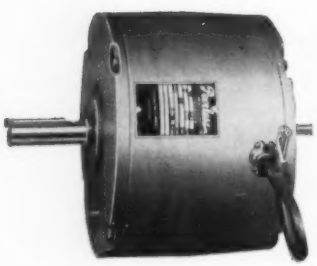


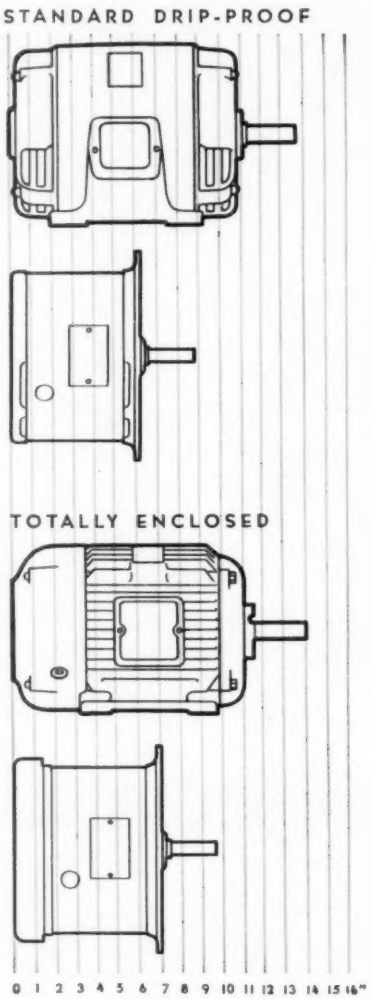
PUSH-BUTTON operated lathe has varied rpm's.

WHEN YOU NEED MORE MOTOR IN LESS SPACE

If your problem is how to put more motor in less space, this Peerless Space-Saver may be the answer. The line includes both drip-proof and totally enclosed designs in ratings from ½ to 10 HP. Bearings are pre-lubricated, double-shielded type. Peerless will work with you to build in any special requirements—torque, mounting, enclosure, duty, or insulation. Peerless Space-Savers cataloged in Bulletin SP-1 meet all NEMA performance standards.

Peerless is a specialist in OEM applications. Close cooperation with your engineers assures the development or selection of the one motor that powers your product. There's a Peerless sales engineer near you. If you don't know him, write to Peerless.





WRITE FOR Bulletin SP-1. It gives complete data on Peerless Space-Savers and lists nearby Peerless sales engineers.

ELECTRIC MOTOR DIVISION

THE Peerless Electric® COMPANY

FANS · BLOWERS · MOTORS

1512 W. MARKET ST. · WARREN, OHIO

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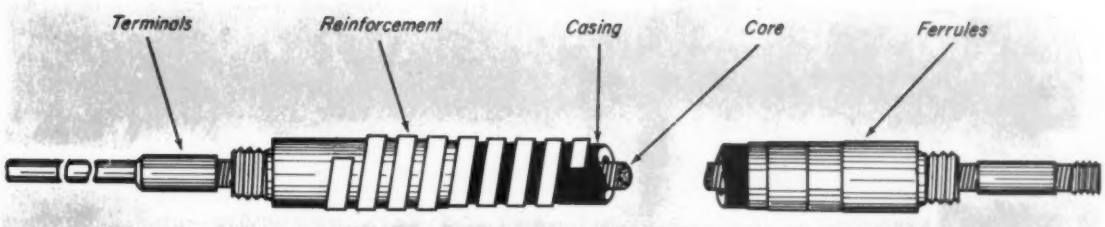

To transmit power in any direction, here's . . .

How to select flexible shafting

FLEXIBLE SHAFTING PROVIDES a simple low cost means of conveying power. It is easy to install and does not require accurate alignment. It gives freedom in locating the driving and driven equipment.

Flexible shafting consists of a core rotating inside a metal or rubber-covered casing. The core is usually made of a straight center wire, wrapped with layers of wires, each layer being wound at a specific lead angle on top of the preceding one and in the opposite direction. The outer layers are generally of larger diameter than those nearer the center.

The shaft gives up high torque to gain flexibility, and in general, the more flexible it becomes, the less torque it will transmit.

How to Specify

The steps in specifying shafts for any application are to select the core, casing, and end terminals. The factors that must be considered are: torque, speed, bends, direction of rotation, life, length, and operating conditions.

Torque

The maximum torque that a shaft will be required to transmit is computed by

$$\text{Torque (lb-in.)} = \frac{\text{hp} \times 63{,}000}{\text{rpm}} \quad \text{.....(1)}$$

Manufacturer's torque ratings are based on continuous operation at given torque. Sudden overloads at starting or stopping which exceed the rated torque may kink the core. This distortion will cause excessive friction between the case and core and result in overheating, early fatigue and breakdown. To prevent this, maximum torque that the shaft will have to transmit should be used in making the selection.

Operating Speed

Since torque ratings for all sizes of shafts are determined at the same speed in surface fpm, rated rpm decreases as shafts get larger. Torque capacity is inversely proportional to rpm at speeds above rated speed. To find torque capacity at higher speeds, simply multiply rated torque by rated speed and then divide by operating speed.

For constant hp, the higher the operating speed the lower the torque. At speeds below rated speed, where the rated torque does not increase with decreasing speed, run the shaft at as high a speed as possible thereby reducing the torque which means a smaller flexible shaft.

Radius of Curvature

The curve that should be considered is the bend which, during normal operation, has the smallest radius. This is obvious by glancing at Table 1; the smaller the radius, the lower the torque capacity. This is because, when the shaft is bent the core resists bending to a degree causing pressure between the core and casing. The sharper the bend, the more the pressure and for a given torque there is greater friction and more heat.

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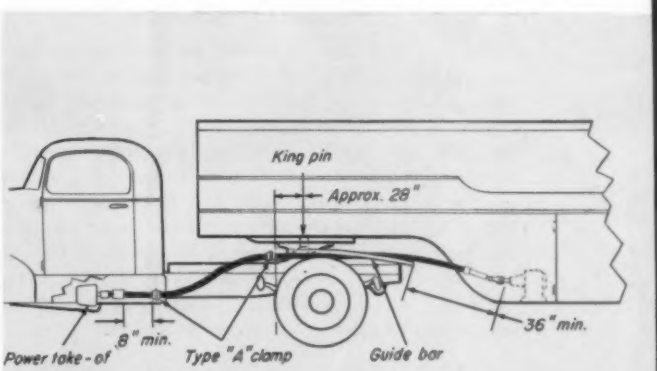
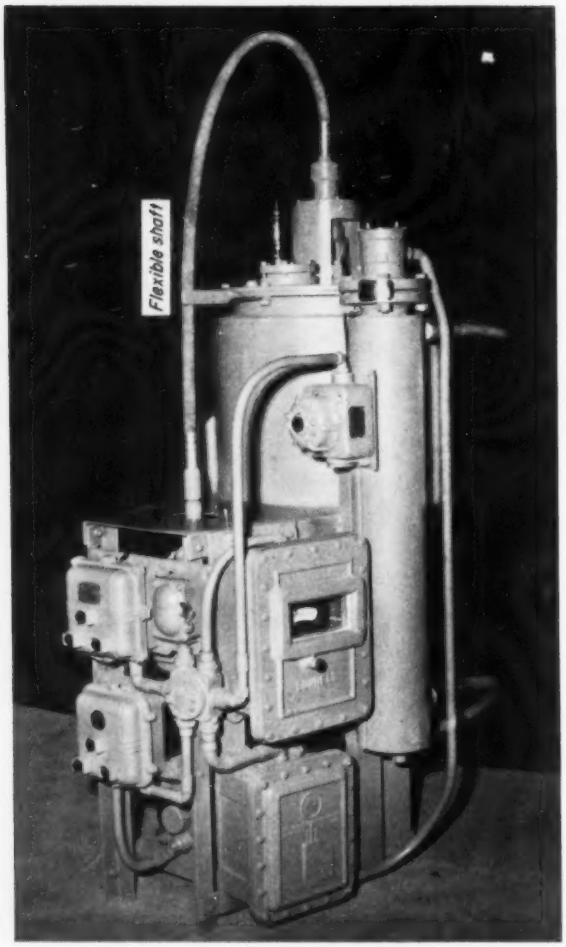


FLEXIBLE SHAFTING drives hydraulic pump.

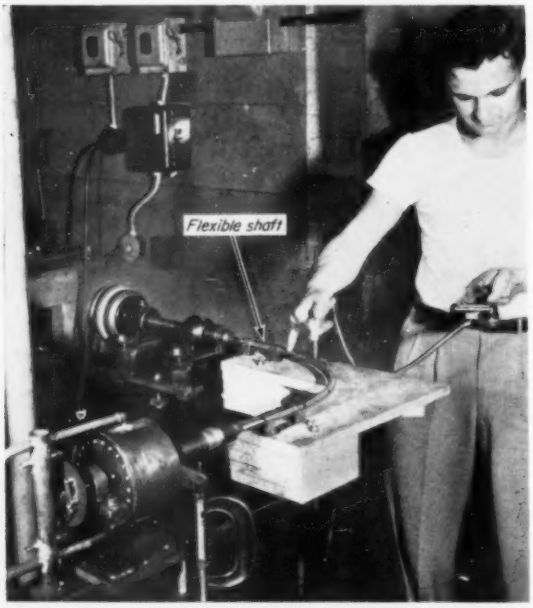
No. 2. For more information on flexible shafts, see page 57

FLEXIBLE SHAFTS *continued from preceding page*



SHAFT JOINS MOTOR with remote work spindle▲

SHAFT goes around corners without appreciable power loss, eliminating coupling, chain, belts and gears



COAL DRILL operates at 3600 rpm with 1-inch shaft►

Direction of Rotation

The layers of wire on a shaft act like springs. Each layer either unwinds or tightens down on the under layer depending on the direction of rotation. Therefore, it is important that the shaft be rotated in the direction that tends to tighten the outer layer of the core. When this rotation is known, you should specify a right hand shaft for clockwise rotation and a left hand shaft for counter-clockwise rotation. The torque capacity of a shaft operated in the unwind direction is about 60 per cent of that in the wind up; so where standard shafts must rotate in both directions, lower torque must be used.

Length

Long lengths are no problem up to 30 feet. Longer lengths are usually prohibitive due to cost. Special fittings are used since the change in length that occurs when a shaft is under load would be so great with such a long shaft that the fitting would slide out of engagement.

If the application is for a short shaft, you must determine if the size required can make the necessary bends. To do this, subtract the length of the stiff portion at the terminal ends from the total length. The radius of bend of the free flexible shaft should be larger than the minimum operating radius of the shaft. If it is not, a change must be made to reduce the sharpness of the bend.

Special Operating Conditions

Torque ratings are for continuous operation. When a shaft runs only intermittently, it will not have time to heat up. Also the shaft life will be longer. When operation is intermittent, torque ratings may be exceeded.

Torque ratings are also only for shafts that are adequately supported along their length (approximately every 3 feet). When no clamps are used, the shaft is apt to tie itself in a knot. For this reason, as a safety factor for unsupported shafts, multiply the calculated torque by 1.6.

Casing Selection

Flexible casing is essential. It acts both as a continuous guide and a bearing surface for the core. It prevents the core from helixing when under load, thereby increasing the shafts' torque capacity. The casing protects the core from damage, dust, and corrosion, helps to retain the lubricant. Selection depends on operating conditions as well as cost. Manufacturers have charts of the standard casings they make showing dimensions and weight.

End Terminals

The core must be connected independently of the casing since only the core rotates. The terminal on a core is called a fitting, while that on a casing is called a ferrule.

Most manufacturers supply standard shafts with built-in sleeve or ball bearings at each end. With this type terminal, it is very easy to install the shaft with a simple coupling. These shafts are often used where either the driving or driven components cannot be changed easily to adapt to flexible shafting fittings and ferrules, such as on a truck to drive an auxiliary pump.

Maintenance

Shafts are ordinarily lubricated at intervals with a light grease. Since the outer layer of wire of the core tends to act like a screw, it will eventually force most of the grease down to one end of the shaft, leaving the other end dry. In most cases, it is easy to tell when lubrication is necessary since the casing will heat up. To lubricate the shaft, remove the core, put on a light coating of grease and replace the core in the casing. Do no pack the grease since this adds to the torque load of the shaft.

Example

Transmit 1 hp at 1350 rpm with an unsupported flexible shaft in a 25 in. radius; starting torque is 150% of normal operating torque.

Solution

(1) Calculate torque (lb-in.)

$$\frac{\text{hp} \times 63{,}000}{\text{rpm}} = \frac{1 \times 63{,}000}{1350} = 46.7 \text{ lb-in.}$$

(2) Correction factor for starting torque 1.5 x 46.7 = 70

(3) Correction factor for unsupported shaft 70 x 1.6 = 112 lb-in.

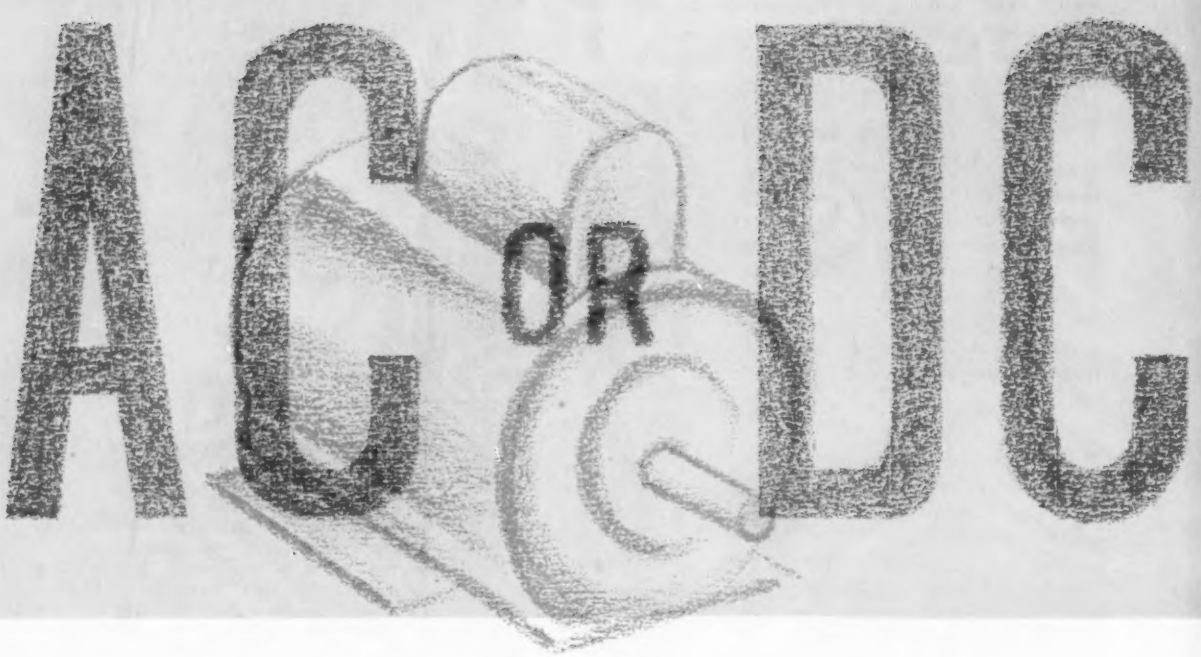
(4) Refer to Table 1. Read downward in column under 25 in. radius until you find a core having a torque rating of at least 112 lb-in. Find core No. 12 is rated 124 lb-in., at 1150 rpm. Since speed is 1350 rpm, multiply 124 by 1150 and divide by 1350 = 106 lb-in (rated torque at 1350). Since the calculated torque at this speed is 112, this core is not satisfactory, and the next size should be tried. Core No. 13 is correct. Here is how the construction of the two smaller cores differ:

core number	layers of wire	wires on outside layer	sizes of wire in outside layer
No. 11	6	6	.063 in.
No. 12	8	7	.048 in.

Rated speed rpm	50 to strght.	RADIUS OF CURVATURE IN INCHES										Wgt/ C. ft.	Core dia.	Core no. and type	Shaft size
		25	20	15	12	10	8	6	5	4	3				
4,500	2.4	2.2	2.0	2.0	1.92	1.9	1.7	1.5	1.25	1.00	.50	3.0	.124/.128	1 MH	13
3,800	7.0	6.4	6.0	5.8	5.4	5.0	4.6	3.6	2.0	1.5		4.5	.148/.152	2 MH	15
2,900	9.4	8.6	8.0	7.6	7.0	6.6	6.0	4.8	3.4	2.0		7.0	.185/.189	3 MH	19
2,500	22.0	20.0	18.8	17.6	16.0	15.0	12.6	10.8	9.0			12.5	.247/.252	4 MH	25
1,800	30.0	28.0	26.4	25.0	23.0	21.0	18.0	14.0				20.0	.308/.313	5 MH	31
1,800	33.8	31.5	29.7	28.1	25.9	23.6	20.2	15.8				20.0	.308/.313	6 T	31
1,800	36.0	33.0	31.6	30.0	28.0	26.0	22.0	18.0	11.0			21.0	.324/.329	7 A	31
1,500	80.0	66.0	63.0	58.0	51 0	46.0	37.0	22.0				28.5	.368/.374	8 A	38
1,500	60.0	54.0	50.0	46.0	42.0	38.0	30.0	24.0				29 0	.387/.393	9 MH	40
1,500	90.0	81.0	75.0	69.0	63.0	57.0	45.0	36.0				29.0	.387/.393	10T	40
1,150	136.0	110.0	104.0	94.0	80.0	72.0	56.0					50.5	.497/.503	11A	50
1,150	148	124	110	92	72	56						53.5	.505/.511	12T	50
900	248	200	176	124	84							78.5	.610/.618	13T	63
900	220	204	192	180	152	130	MAXIMUM DYNAMIC TORQUE CAPACITY (LB.-IN.)					80.5	.630/.638	14A	63
750	340	224	156	76								117	.747/.753	15T	75
600	760	520	420									205	.998/1004	16T	100
440	1,500	720										343	1298/1304	17T	125
440	1,650											343	1303/1308	18T	125

Above rated speed, torque capacity decreases as speed increases.

TABLE 1. You can calculate core sizes from these figures.



What factors must be

By RICHARD R. SELLECK, *associate professor, Ohio University*

FACTS ABOUT A-C

WHETHER TO USE a-c or d-c is often based on what type power is available. Usually this is 60 cps a-c, universal throughout the country. A-c might therefore be selected even though d-c is more desirable.

A-c is more complex than d-c. It can be described as a sine wave, and mathematically as

$i = I_{max} \sin \omega t$ .....(1)

where

i = current in amps
I_{max} = maximum height of sine wave of current
ω = angular velocity, radians per second
t = time in seconds

For 60 cycles

$\omega = 2\pi f$ .....(2)

where, f = frequency in cycles per second

Therefore

$\omega = 2\pi 60 = 377$ radians per second
$i = I_{max} \sin 377t$ amps
$e = E_{max} \sin 377t$ volts

where, e = potential in volts.

A-c is not read directly by voltmeters and ammeters. Only its effective values are read. The effective value is that which will produce the same heating as a corresponding d-c current. Therefore, effective a-c current is

$$I_{eff} = \sqrt{\frac{1}{\pi}\int_0^{\pi} i^2 d\,(\omega t)} \quad \text{.....(3)}$$

$$= \sqrt{\frac{1}{\pi} I_{max}^2 \left(\frac{\pi}{2} - 0 - 0 + 0\right)}$$

$$= \sqrt{\frac{1}{\pi} \times \frac{\pi}{2} I_{max}^2} = \frac{I_{max}}{\sqrt{2}} = 0.707\ I_{max}.$$

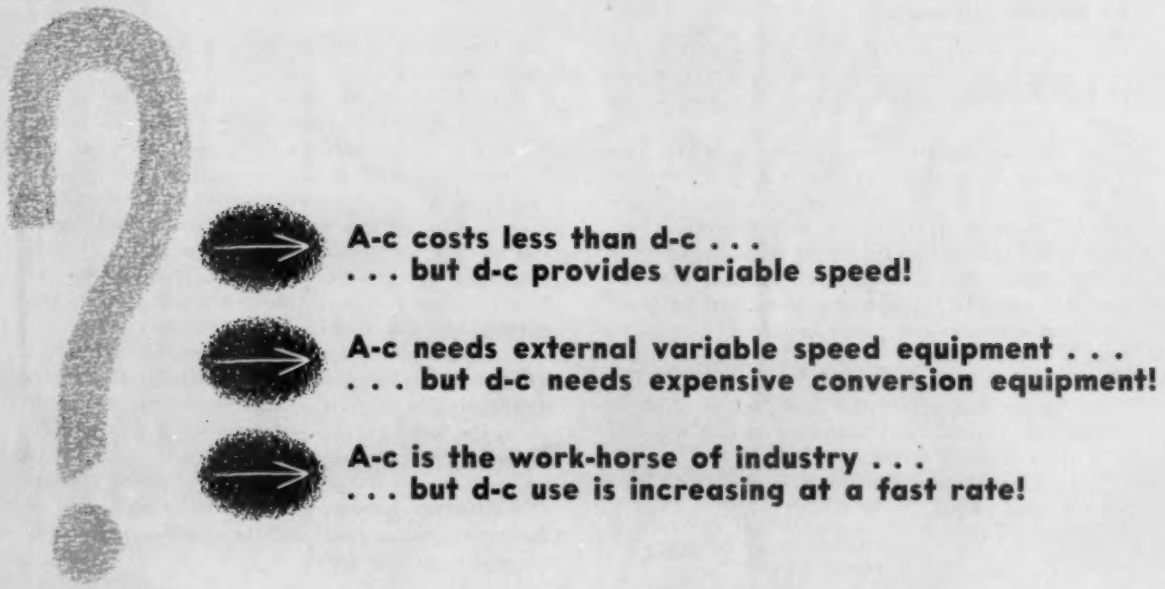
The effective a-c voltage is

$E_{eff} = 0.707\ E_{max}$

A-c power is usually three phase. This means there are three sine waves at the same time, displaced 120 deg apart. Therefore

$i_1 = I_{max} \sin (\omega t)$ .....(4)
$i_2 = I_{max} \sin (\omega t + 120 \text{ deg})$ .....(5)
$i_3 = I_{max} \sin (\omega t - 120 \text{ deg})$ .....(6)

Continued on page 24



considered in selecting motors?

FACTS ABOUT D-C

WITH MODERN A-C TO D-C conversion equipment, d-c motors can be used almost as inexpensively as a-c.

D-c is simple; it is uni-directional and can be described as two straight lines of current—one positive, one negative. It can be obtained in several ways, such as from a battery, dynamo, generator, or by rectifying a-c.

Rectifying a-c can be done electronically with tubes and transistors or with electrical devices. D-c power is equal to the square of the current in amps times the resistance in ohms of the conductor through which the current flows

$$P = I^2R \text{ watts} \quad \text{.....(1)}$$

Current is equal to voltage divided by resistance

$$I = \frac{E}{R} \text{ amps} \quad \text{.....(2)}$$

Both d-c and a-c operate on the same principle, that is, the inter-reaction of the magnetic field of the stationary stator pulling on the magnetic field of the movable rotor. D-c motors can be broken down into three general types: shunt wound; compound wound and series wound.

Shunt Wound

This type motor has desirable variable speed characteristics. It has a stator with a minimum of two magnetic poles excited by the d-c power source; a rotor (or armature); and its commutator. The armature is also connected to d-c through carbon brushes.

Since the rotor turns and the field stands still, a-c is induced in the rotor. The commutator rectifies it and changes it to d-c. The field resistance is high because of magnetic flux. Magnetic flux is produced either by a few turns of large size wire and large field current, or by many turns of small wire and small field current. When many turns are used, high field resistance results; and field current will be small; Total current drawn from the d-c source is equal to the sum of the current required for both field and armature.

Field current is obtained by dividing the applied

Continued on page 25

Three phase power delivers three times more power over three wires than single phase over two wires. This is why three phase is more widely used in industry.

A-c also has feature known as power factor. This is caused by inductance. Inductance is the generation of another current by influence with the primary current. A-c motors are highly inductive. Therefore, current and voltage can get out of phase by an angle θ. This means that a larger current than otherwise needed is required to produce a given wattage (voltage times current times power factor).

This is expressed as

$$P = V_{eff}\ I_{eff} \cos \theta \text{ watts} \quad \text{.....(7)}$$

The larger the angle θ the more out of phase is voltage and current; and the more current required to produce a given power.

Three phase power contains a square root factor for the three phases

$$P_{3\ phase} = \sqrt{3}\ V_{eff\ (line\ to\ line)}\ I_{eff\ (line)}\ Cos\ \theta \quad \text{.....(8)}$$

where, $V_{eff\ (line\ to\ line)}$ = effective voltage measured between two of the three wires; and $I_{eff\ (line)}$ = effective current measured in only one wire.

These equations are limited to applications where voltage between any pair of the three wires is equal; and current in all three wires is equal.

There are several type of pholyphase motors. Single phase motors are not discussed in this article.

Low Slip Induction Motor

The work horse of industry is the squirrel-cage low-slip induction motor. This motor has the same speed-torque curve as the shunt wound d-c motor but cannot have its speed adjusted.

When an a-c voltage is applied to the stator, a magnetic field is set up. This field revolves at a constant speed

$$rpm = \frac{120\ f}{P} \quad \text{.....(9)}$$

where f is the applied frequency, usually 60 cps; and P is the number of magnetic poles.

For a two pole induction motor, the stator field revolves at 3600 rpm; and for a four pole motor, 1800 rpm. The rotor consists of a large number of copper or aluminum bars imbedded in slots in a laminated iron core. Each end of each bar is connected to all of the other bars.

If the induction motor were to run as fast as the revolving field in the stator, there would no longer be relative motion between the bars of the rotor and the revolving field of the stator, and the induced voltage in the rotor would go to zero. When voltage goes to zero, current in the bars also goes to zero, and there is no longer any torque available to turn the rotor. For this reason, it is impossible for an induction motor ever to run at a speed equal to the speed of the flux rotating within the stator.

The speed of the flux in the stator is referred to as synchronous speed. As load is applied to the motor, it must slow up slightly so that the relative speed between the rotor and the stator revolving flux can increase, thereby increasing the induced voltage and the current and flux caused by the induced voltage. The difference between synchronous speed (speed of the stator rotating field) and the speed of the rotor is referred to as slip speed.

High Slip Induction Motor

The high-slip squirrel-cage induction motor is similar to the low slip motor with one difference. The rotor of the high slip motor has a higher rotor resistance. This resistance causes a greater relative speed between the revolving stator flux and the rotor. Applications of the high slip motor overlap those of the low slip. The high slip develops rated output at a slip of about seven percent. Starting current is somewhat less than that of the low slip, about five times rated current. Starting torque is higher than the low slip motor, about 250 percent rated torque, and the maximum or stalling torque is also higher, about 250 percent rated torque also.

The high slip squirrel cage motor has a greater change in speed between no load and rated load than the low slip. It is subject to the same limitations as the low slip in that it will operate at a poor power-factor at light loads, and also at a poor efficiency at light loads.

Both high- and low-slip are used where a nearly constant-speed drive is required. The speed-torque curve for the squirrel cage induction motor is not

Continued on page 37

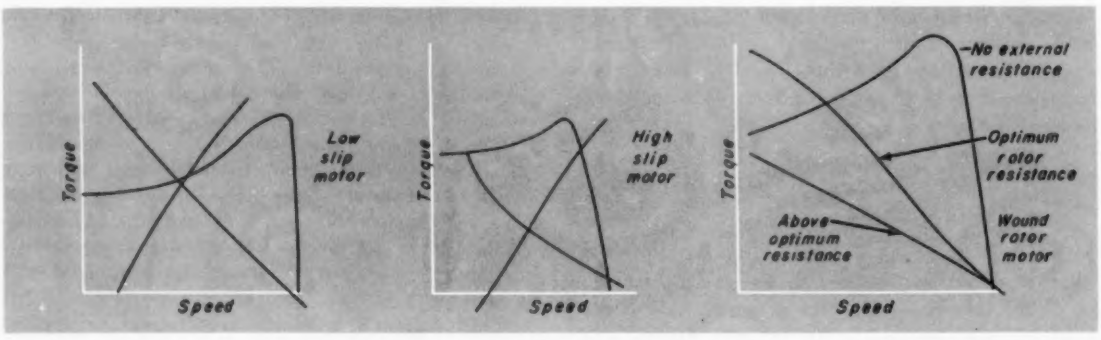


Fig. 1. Speed-torque curves for low slip, high slip and wound rotor motors.

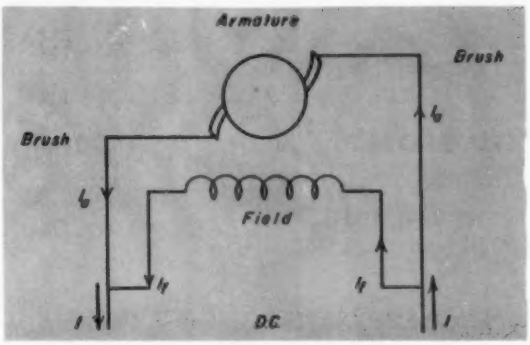


Fig. 2. Diagram of shunt wound motor.

voltage by the total resistance of the field circuit. This not only includes the field itself but also the rheostat which is connected in series with the field. Armature current is obtained by

$$I_a = \frac{V-E}{R_a} \quad \text{.....(3)}$$

Where

V = applied d-c volts
E = induced voltage in the armature (counter emf)
R_a = resistance of the armature in ohms.

Induced voltage in the armature is proportional to the product of motor speed and the flux produced by the field

$$E = C_1 N \Phi \quad \text{.....(4)}$$

Where

C = a constant

Torque is directly proportional to the product of armature current and flux.

$$T = C_2 \Phi I_a \quad \text{.....(5)}$$

Speed is directly proportional to induced voltage in the armature and inversely proportional to flux produced by the field

$$N = \frac{E}{C_1 \Phi} = \frac{V-I_a R_a}{C_1 \Phi} \quad \text{.....(6)}$$

Flux Φ of the field can be varied by a rheostat in series with the field winding. Increasing the field resistance reduces the flux. If for any reason the field circuit is opened so that no current flows, flux will go to or approach zero. This results in the speed of the motor approaching infinity, which causes the motor to damage itself by "running away". It is necessary that the shunt wound motor at all times have field current flowing.

Power output is equal to the product of the induced armature voltage and the armature current minus friction and windage of the rotor. Since for constant field current the induced armature voltage is almost constant, the armature current must increase with power output.

Series Wound

The series wound motor has a very high starting torque. However, it must have a load. Without load, it also will "run away". It is similar to the shunt wound motor in that the stator contains the main magnetic poles. The armature is virtually the same as in the shunt wound. The armature and field are connected in series, thus the field must carry the same current as the armature. Since the same magnetic flux can be produced by either a large number of turns of small wire and few amperes, or a few number of turns of large wire and many amperes, the series motor has a field containing relatively few turns of large wire.

Since the same current flows thru the armature and the series field, the flux produced by the field is proportional to the armature current. Taking into account the proportionality of flux to armature current

$$T = C_3 I_a^2 \quad \text{.....(7)}$$

Torque of a series motor is proportional to the square of the armature current. Since the resistance of the series field and the armature are both small, current at the instant of start is large. The torque is proportional to the square of the armature current and results in maximum torque at the instant of starting. This is a very important feature of the series motor.

As a series motor increases in speed, the armature current decreases due to the increase of the induced voltage. This decrease causes a decrease in the flux produced by the field, since the flux is proportional to the armature current. The decrease in flux causes a further increase in speed. The increase in speed causes a further drop in armature current and reduc-

Continued on page 37

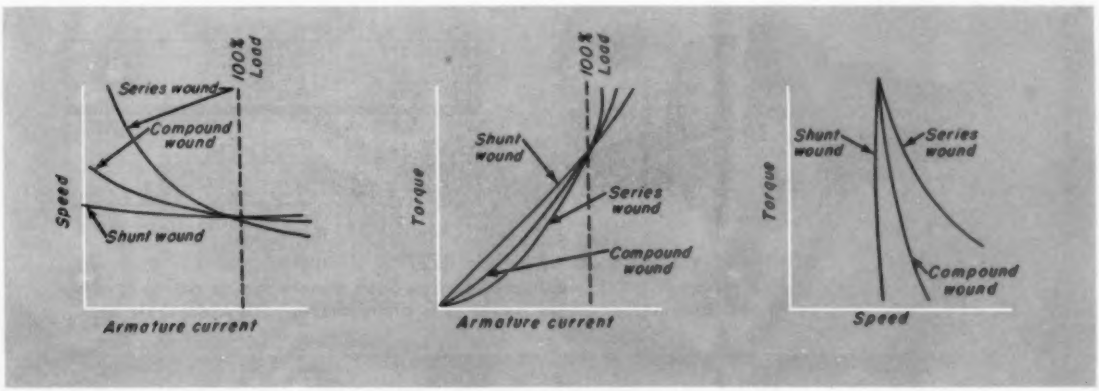


Fig. 3. Comparison of shunt wound, compound wound, and series wound motors.

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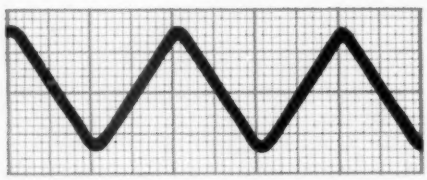
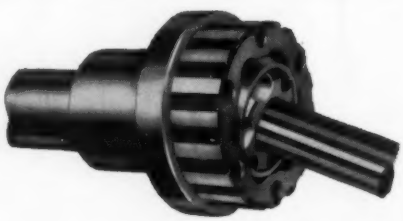
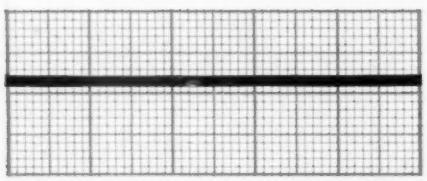


ORDINARY CROSS OR PIN UNIVERSAL JOINT — Mathematics and geometry prove this joint changes velocity of the driven shaft with two high points and two low points per complete revolution. This fluctuating torque action causes vibration and wear throughout entire driving mechanism.





CONSTANT VELOCITY JOINT — This RZEPPA design joint *always* transmits smooth torque even at unbalanced angles. Such smooth torque action results from ball bearings applying power in a plane that bisects both shaft axes.

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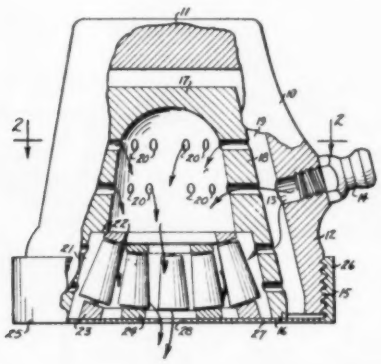
PATENTS

Bearing lubricator

U. S. Patent No. 2,866,520; John L. Sharp, Ontario, Calif.

A hollow housing of frustro-conical shape with a cavity for holding a supply of lubricant. The cavity has

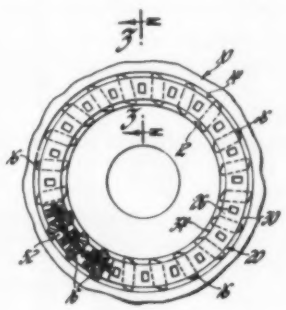


a number of spaced holes that allow lubricant to feed to the cavity as well as to the bearing. A fitting in the housing wall feeds lubricant into the housing.

One-way clutch

U. S. Patent No. 2,870,890; Leland D. Cobb, Forestville, Conn., assignor to General Motors Corp., Detroit, Mich.

For use between a pair of relatively rotatable coaxial races, the clutch has an annular cage positioned between and spaced from the races. The cage has two end rings joined by axially extending flat cross bars. Sprags are positioned between the flat cross bars. A



spring through holes in the sprags and cross bars maintains race spacing.

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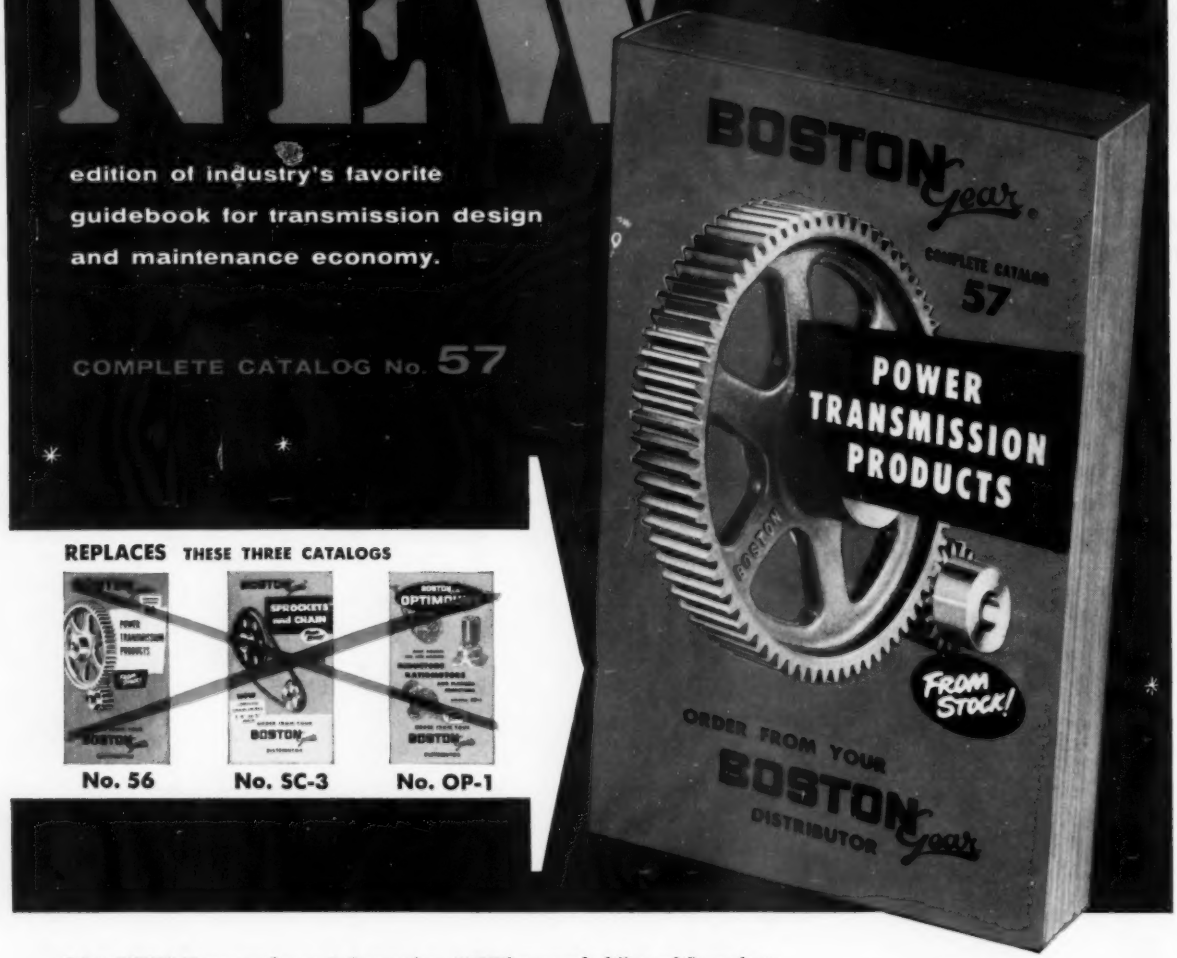

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Gear and brakehub sustain start-stop action

INTERMEDIATE GEAR and brakehub make it possible to have sustained braking and start-stop action in a chain hoist.

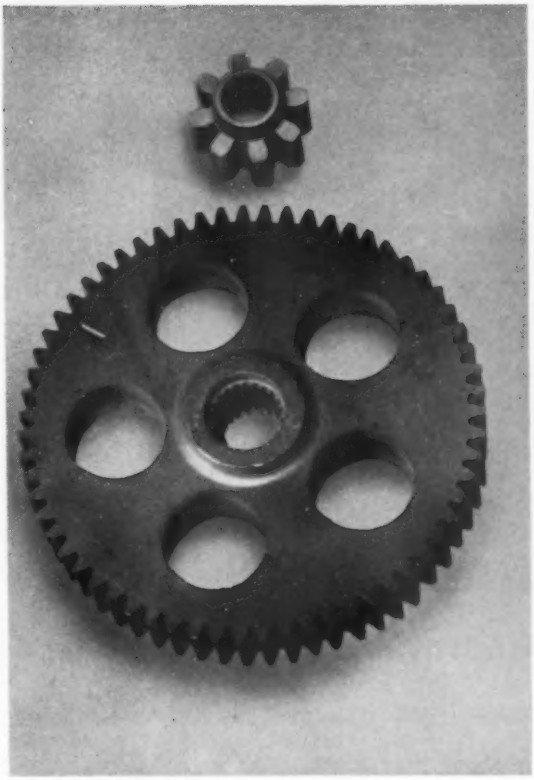
The brake hub allows the electric brake's friction discs to positively control load-motion and rotation of the drive shaft. The intermediate gear is part of a two-reduction gear train transmitting power from the motor to lift wheel.

In a former design, the hub was machined from bar stock. Now made of powdered metal, part-costs are lowered about 70 cents per part. The gear is sintered from iron powder, holding close tolerances.

Problem facing design engineers was: How to bring full load to speed of 32 fpm, then brake to zero speed.

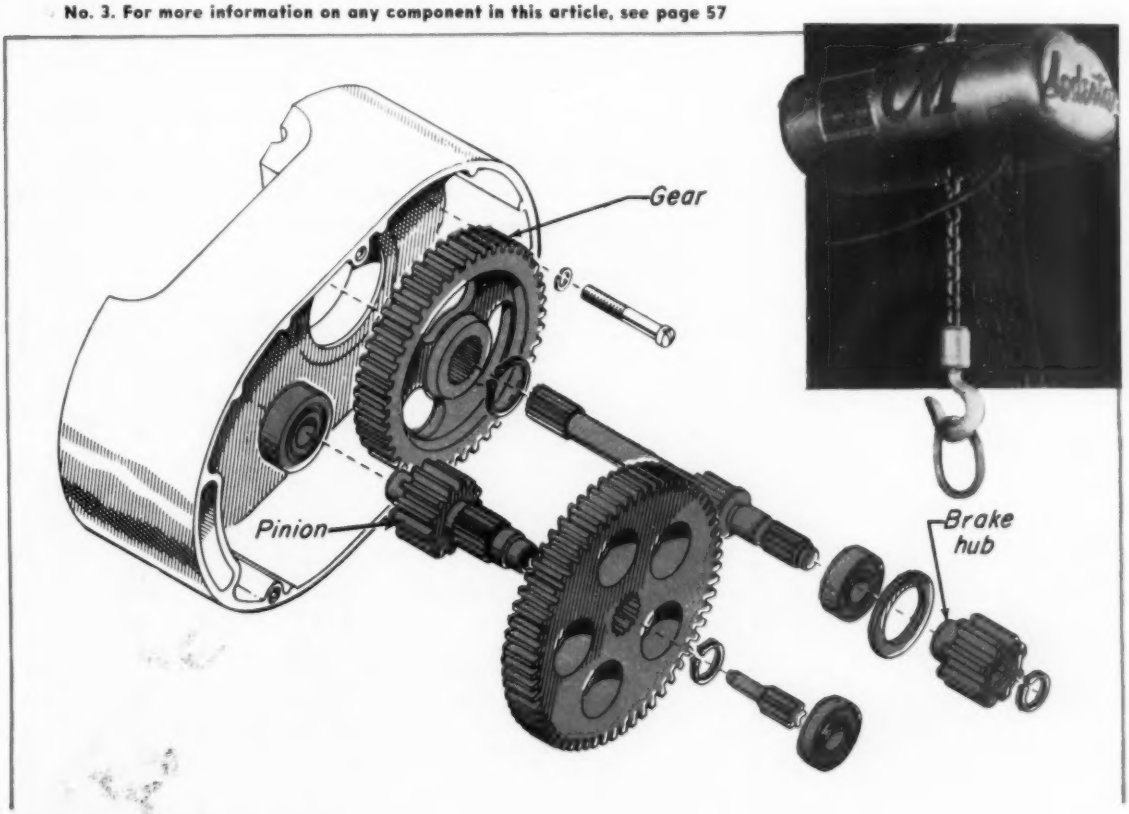
When hoisting, motor holds load after the magnetic brake opens. When lowering, motor acts as generator to hold load and lower it at hoisting-speed. A vertical, disc-type magnetic brake is used.

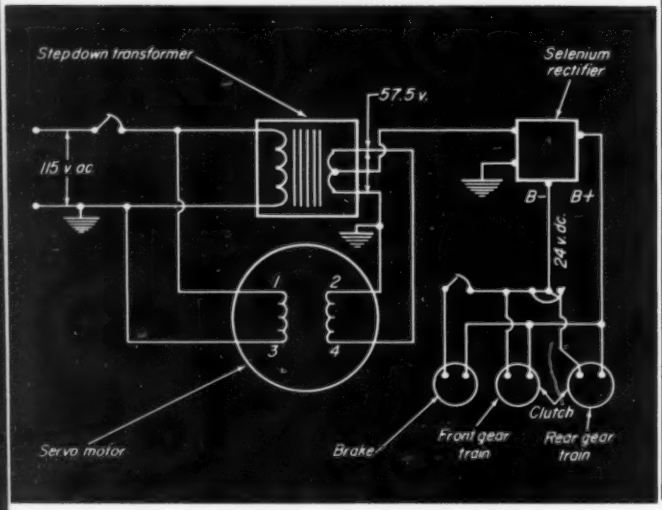
Gear and hub application in chain hoist is by the *Chisholm-Moore Hoist Div., Columbus-McKinnon Chain Corp.*, Tonawanda, New York.

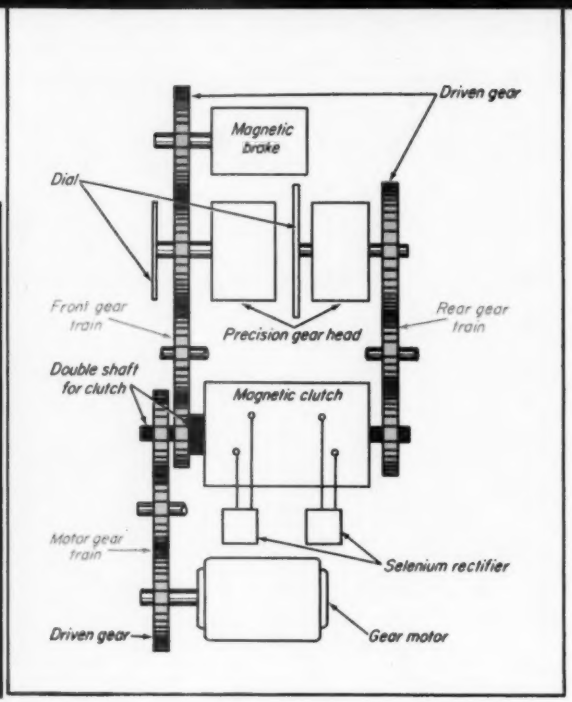


GEAR AND BRAKEHUB make start-stop action possible.

No. 3. For more information on any component in this article, see page 57







Gearmotor powers two gear trains at different speeds

GEARMOTOR drives two gear trains at different speeds to give precise dial readings on an aircraft-computer.

The problem was: To drive the dual gear trains at different speeds to provide different dial readouts—from a single motor-speed. Front gear train gives readings on drift-angle. Rear gear train provides data on the degrees of heading.

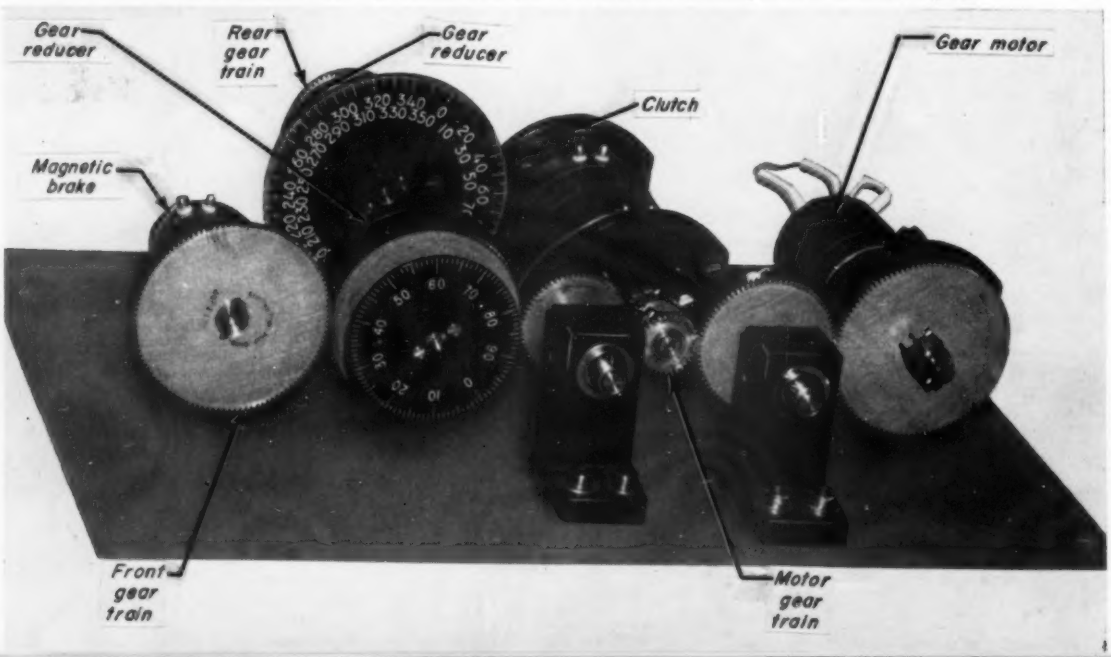
The gearmotor drives a primary train of three gears tied to the driving shaft of a triplex magnetic clutch. Driven from this shaft is the front train of reduction gears. Their ratio is lowered further by a gear reducer delivering correct rpm's to the front dial showing drift angle. When rear dial readings showing degrees of heading are desired, a magnetic brake on the drift-angle dial is energized by a switch on the control panel. This stops the front gear train. At the same time, the magnetic clutch is energized so that the small shaft turns, driving the rear gear train and transmitting power through a gear reducer to activate the rear dial showing degrees of heading at the specified rpm's needed for a precise readout.

The result is that reduction ratios of both trains differ greatly while the motor-speed remains constant.

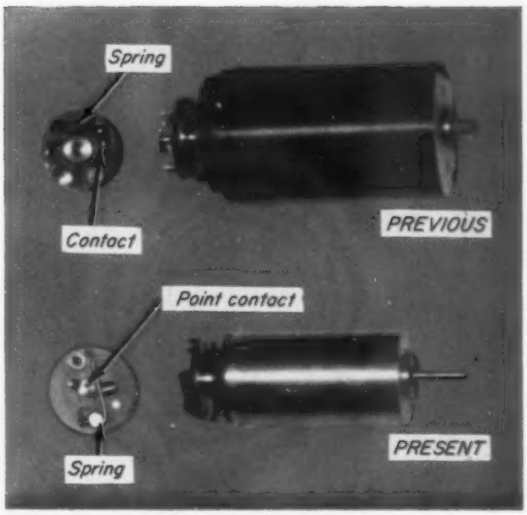
The unit is the development of *Sterling Precision Corp., Instrument Div.*, Port Washington, New York.

No. 4. For more information on any component in this article, see page 57

DOUBLE GEAR TRAIN gives dial readouts on aircraft's heading-drift and drift angle.



New type brush cuts torque on small motor-rotor



MINIATURE MOTORS with both old and new brushes.

MINIATURE MOTOR efficiency is now increased by using new type spring and point-contact brushes that reduce torque on the rotor.

The motor formerly had a conventional brush that pressed against both sides of the governor, exerting pressure as indicated in the drawing at lower right. Torque was high. But the new design uses a spring contact on a point at the governor.

This torqueless contact is shown in drawing below at left. Other brush makes contact by means of a spring with contact-brush pressing against the shaft which turns under it. Here torque is negligible.

Pressure on the governor-brush causes friction and slows down the rotor action. Ordinary torque produced this way on conventional permanent magnet, miniature motors causes 10% output loss. The old motor before brush re-design was 3000-6000 rpm, .001-hp, d-c, 10 volts, 55 milliamps (no load), 60-70 milliamps (load).

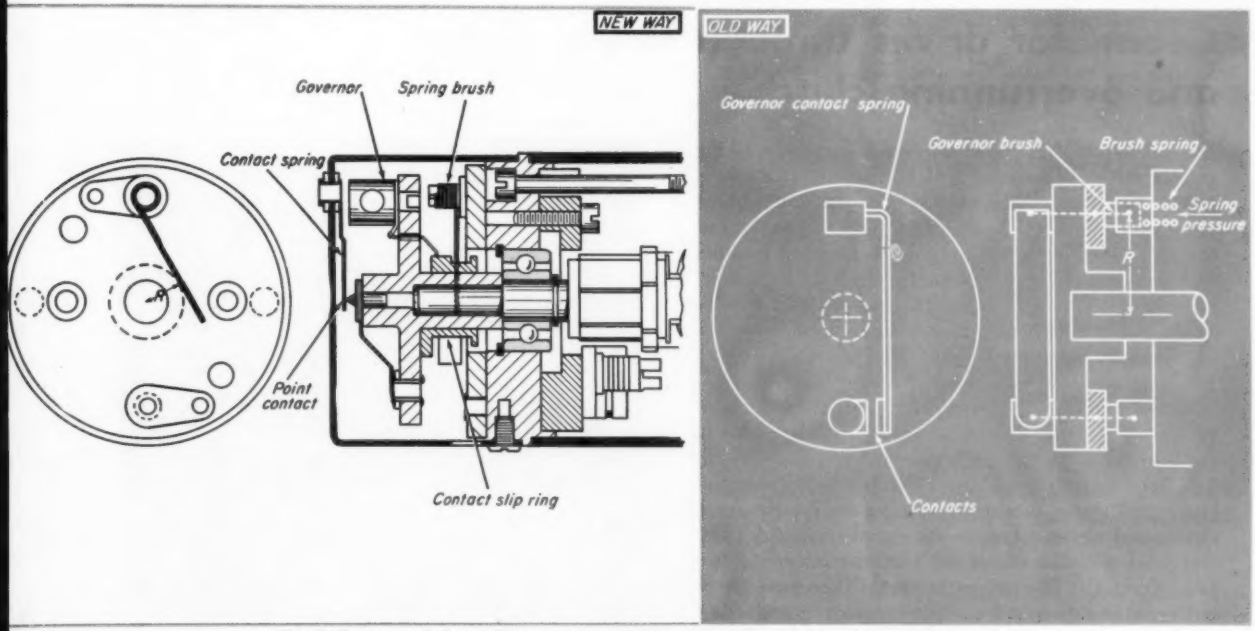
The new motor is .002-hp, 3000-6000 rpm (adjustable governor), 10 volts, d-c, 55 milliamps (no load), 60-70 milliamps (load).

Using the spring contact and the point-tip contact, without the governor, it draws 35 milliamps; with the governor, 37 milliamps. Thus low power overcomes friction-torque of governor bearings. On the new motor, current runs directly into the shaft where spring makes contact. Radius must be small because torque lessens as radius shortens. A small amount of pressure exerts a great torque on a wide radius.

The new small-motor brush is the development of *Heinz Mueller Engineering*, Chicago, Ill.

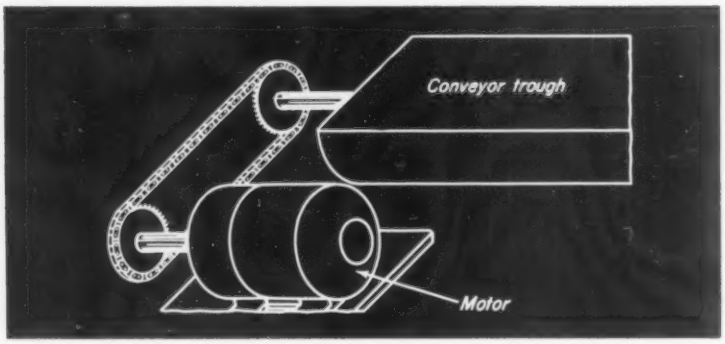
LOW TORQUE contact is made with spring and point.

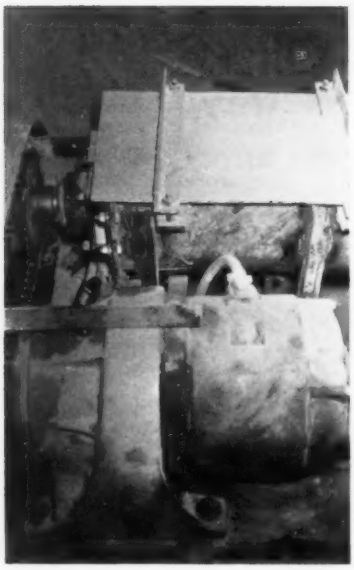
MUCH TORQUE results with conventional brushes.



No. 5. For more information on any component in this article, see page 57

Gearmotor, chain eliminate conveyor breakdowns





GEARMOTOR AND ROLLER CHAIN have eliminated constantly recurring breakdowns of the drive on a screw-type cement conveyor. Before the changeover, a speed reducer mounted at the drive end of the screw was constantly breaking down. Thrust of the inclined screw and its load of cement, coupled with cement dust, were just too much for the reducer.

The reducer was removed and replaced by a heavy-duty thrust bearing, and a sprocket mounted on the end of the conveyor shaft. A gearmotor mounted to one side of the conveyor housing drives the screw through a length of roller chain. The chain, as the photo shows, is exposed to cement dust as well as any other airborne dirt since it is covered only on one side by a sheet-metal guard. Operation of the re-powered conveyor has been entirely satisfactory.

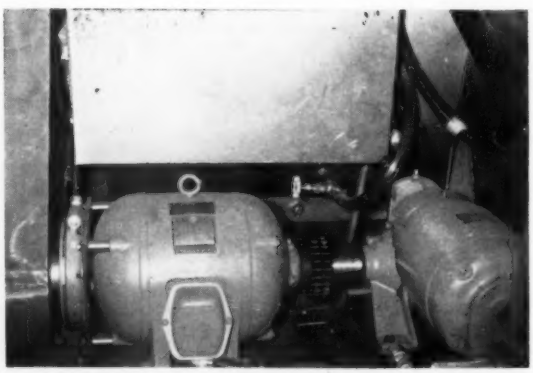
This installation is at the *Oscar Roberts Co.* plant in Minneapolis, Minn.

No. 6. For more information on any component in this article, see page 57

Gearmotor drives through larger motor and overrunning clutch

TWENTY-TO-ONE speed difference for the washing and extracting cycles on a dry cleaning machine is gotten from a system where a gearmotor drives through an overrunning clutch and a high-speed motor. On one end, the 86-rpm gearmotor drives the double-ended 1750-rpm motor through the overrunning clutch and roller chain coupling. On the opposite end, the 1750-rpm motor connects to the washing drum by multiple V-belts. The belt sheaves give reduction of about 4.5 to one.

In operation, the drum is driven for about 40 minutes an hour by the gearmotor, which is 3 hp. This is the washing portion of the cycle. Then the 7½-hp, 1750-rpm motor cuts in for 12 minutes. Because the high-speed motor is already turning 86 rpm, current inrush and starting torque are greatly reduced. The overrunning clutch allows the 1750-rpm motor to run away from the 86-rpm gearmotor. Therefore, there are no starting, stopping, clutching, or gearshifting problems.

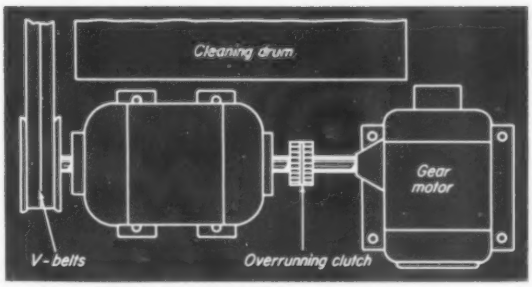


RIGHT-ANGLE GEARMOTOR drives dry cleaning machine drum through an overrunning clutch and standard motor. Chain-sprocket coupling between the gear motor and high-speed motor has one sprocket integral with the overrunning clutch.

High-speed part of the operating cycle is for solvent recovery. Centrifugal force, during spinning of the drum really gets the clothes dry. The remaining 8 minutes of the hour are used to unload and load the machine.

This system is the simplest and most reliable method possible for this job. One of the sprockets of the coupling between the gearmotor and the high-speed motor is integral with the overrunning clutch.

This machine is designed and built by *VIC Mfg. Co.*, Minneapolis, Minn.



LAYOUT of dry cleaning machine drive.

No. 7. For more information on any component in this article, see page 57

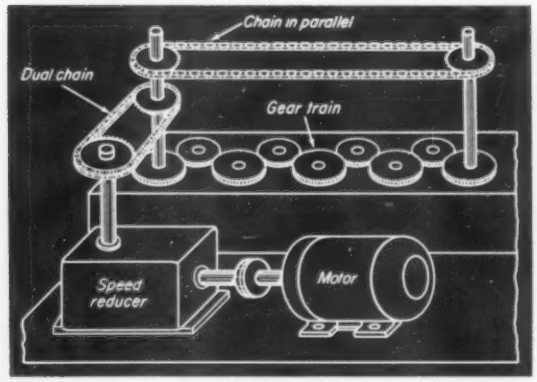
Roller chain in parallel stops gear breakage

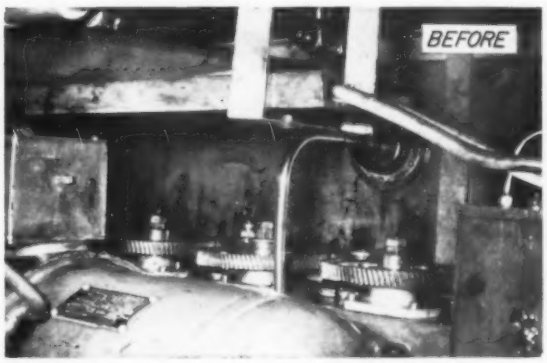
GEAR BREAKAGE on a machine for continuous processing of 35-mm color film has been eliminated with a roller chain drive in parallel with the gear train. Breakage of the helical gears at the head end of a long gear train for driving the film transport rollers was both annoying and costly because of the time required to replace broken gears and the damage to film. When a breakdown occurred, film in process staying in the processing solutions for too long a time. Since film processing is done in total darkness, repairs were hard to make.

Because replacement of the entire gear train was expensive in time and money, the plant engineer decided to try the parallel roller chain drive across the portion of the train where breakage occurred. To do this, it became necessary to replace two shafts with shafts long enough for mounting the sprockets and add a bearing at the top of the two vertical shafts.

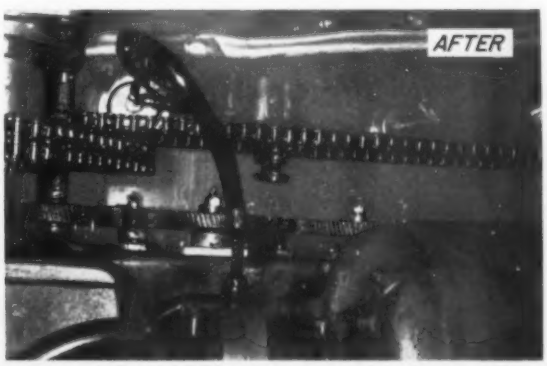
Since the machine was made in Europe, it was decided to replace the gear box driving the train with domestic components at the same time the parallel chain was added. The original motor was used by matching mm size to the new speed reducer, and a dual chain drive. Sprockets for the dual drive are mounted on the same shaft as the drive sprocket for the parallel chain drive. Since completion of this work, there has been no trouble with gear breakage on the machine.

This installation is at *Berkey Photo Service, Inc.*, New York.





BEFORE the chain drive was added and new drive units installed.



DUAL CHAIN INPUT sprockets and the drive sprocket of the parallel chain drive mount on the same shaft.

PARALLEL CHAIN DRIVE eliminates helical gear breakage at the head end of a long train of gears.

No. 8. For more information on any component in this article, see page 57

SPEED CONTROL handle is seen in photograph at right. Crawl titler is powered past the opening through which CBS special effects director, Austin Huhn, is peering. Schematic at bottom of page outlines power-drive system of fluid-coupling, chain and sprocket.

Fluid coupling answers speed control problem

FLUID COUPLING gives jerkless, silent, back and forward speed control of chain driven pair of rollers holding a credit-title scroll for TV cameras.

Problem facing special effects men was: How to get a fractional horsepower motor to power graphic material on rollers, and do it at a readable speed?

They needed a unit with speed that was variable while the machine was in motion. It had to be reversible, and because paper was carried by the rollers, it had to start evenly without yanking.

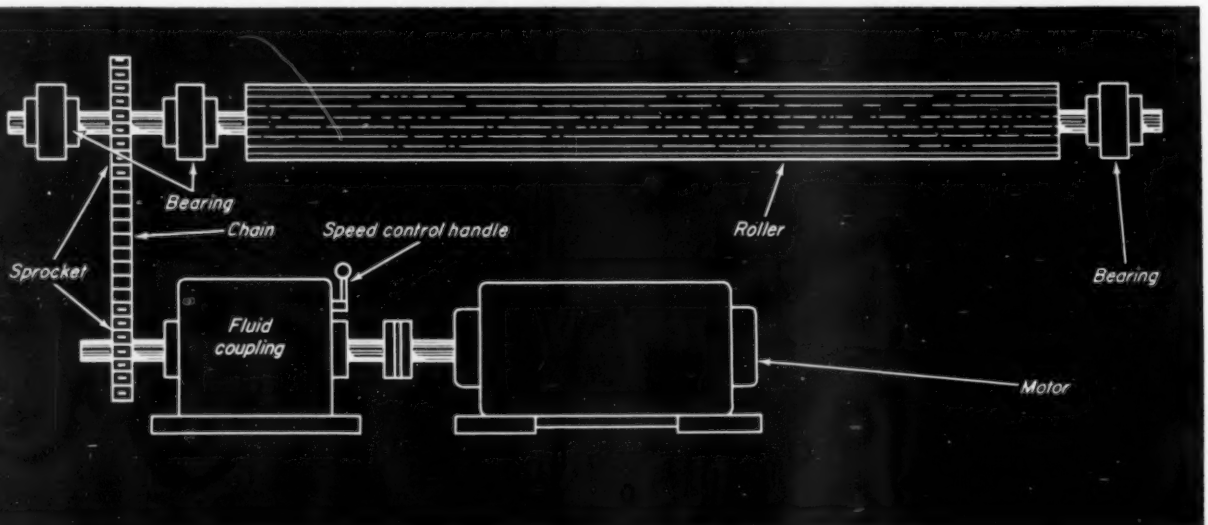
Using the fluid coupling gives a silent drive without friction. Coupling specifications are: 0-500 rpm, and long-start.

It varies speed by changing the fluid's orifice-size. Changing direction of the coupling's vanes reverses the drive.

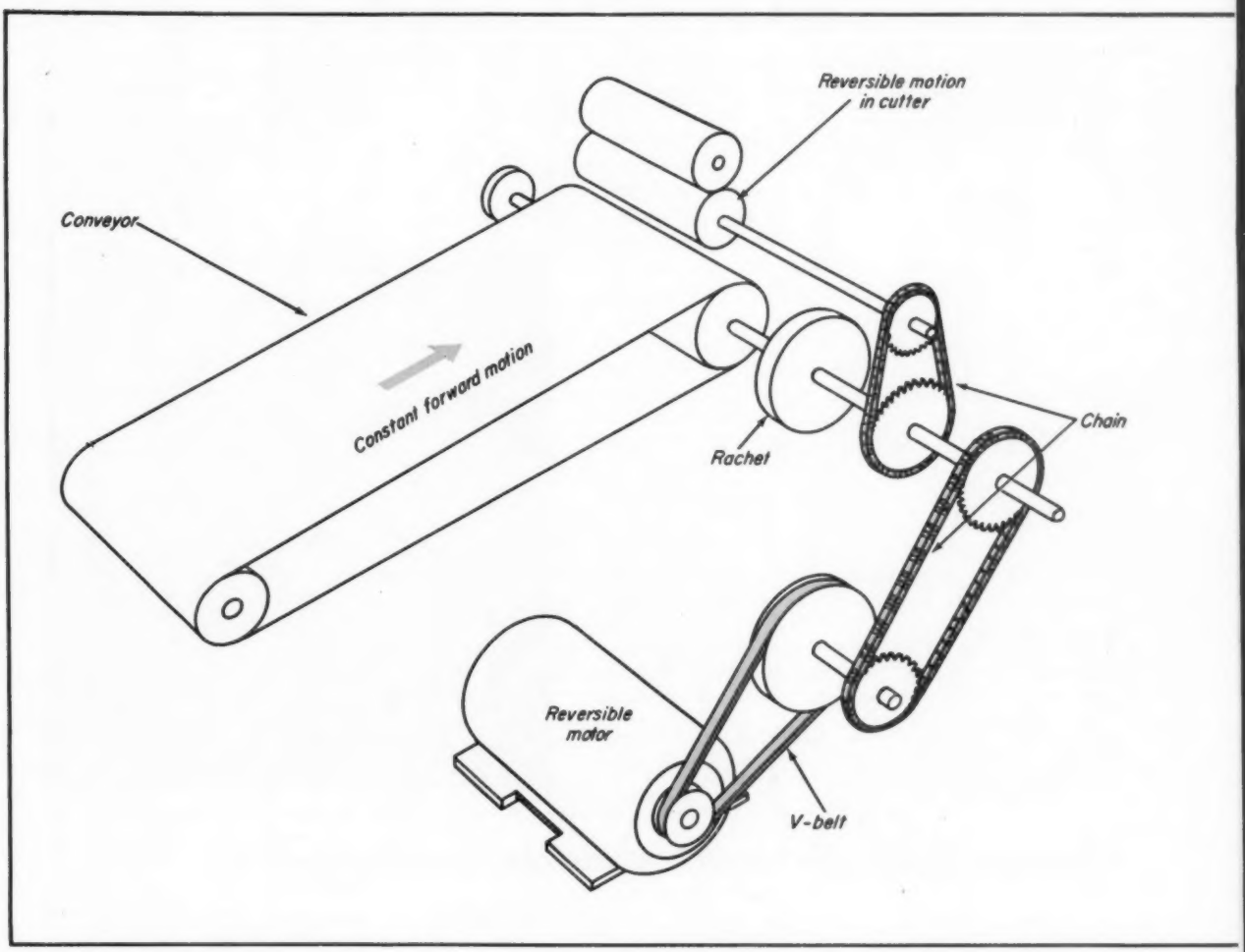
Unit is powered by 1100 rpm, a-c, single-phase, synchronous, 1/25-hp motor. Power transmits through chain and sprocket to the bottom roller, then top roller. Both turn at 0-125 rpm.

The titler is in use in TV studios of the *Columbia Broadcasting System*, in New York City.

No. 9. For more information on any component in this article, see page 57



Chain drive synchronizes conveyor and knife speed



CHAIN DRIVE powers both knives and conveyor. Conveyor moves in forward direction only.

CHAIN AND SPROCKETS synchronize the drive of shredding knives and material-conveyor in a paper products plant.

Ratchet attached to the driving shaft of the conveyor allows reversal of the drive to clear knives when they become jammed with shredded paper.

Problem first facing development engineers was producing a machine which would have conveyor belt speeds and shredding knife speeds co-ordinated. This kept paper moving through the cutting end of the unit as fast as it could be processed—and no faster.

Second problem came when shredded paper jammed knives and motor was reversed to clear them. The conveyor loaded with uncut paper, was also reversed, dumping its load on the floor and damaging the stock.

Solution to problem one was a pair of chains and sprockets that drive the shafts which turn both the conveyor and the shredder. Solution to the second problem was a one-way ratchet mounted on the conveyor's drive shaft, allowing it to turn in a forward motion but letting it ride free when the shaft is reversed.

The unit is powered by a 3-hp, reversible, 3-phase, a-c, 1725 rpm motor. The motor drives a single-groove pulley and V-belt, turning a jackshaft-mounted pulley with a 3:1 speed reduction.

Sprocket mounted on this jackshaft drives a chain which turns a driven sprocket at 120 rpm mounted on the shredder's cutting shaft. Second sprocket mounted on end of cutting shaft powers a third sprocket driving the conveyor. The ratchet is also mounted on this shaft, allowing the conveyor to move in only one direction.

This chain-sprocket unit is the development of the *Shredmaster Corp.*, in New York City.

No. 10. For more information on any component in this article, see page 57

Planetary gears replace costly hand operation

PLANETARY GEARS drive heavy cleaning brushes, replacing manual production operations in a portable cable manufacturing plant.

Cable is covered with extruded jacket over rubber inner-sheathing. The under-sheath is semi-vulcanized in finely powdered talc which adheres tightly to the rubber. These particles must be removed before extrusion operations begin in order to assure a secure bond between insulation and sheath.

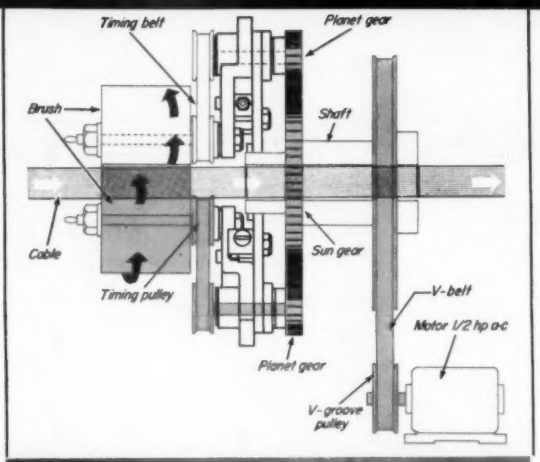
Only previous means of cleaning cable was to scrub it by hand, a tedious operation.

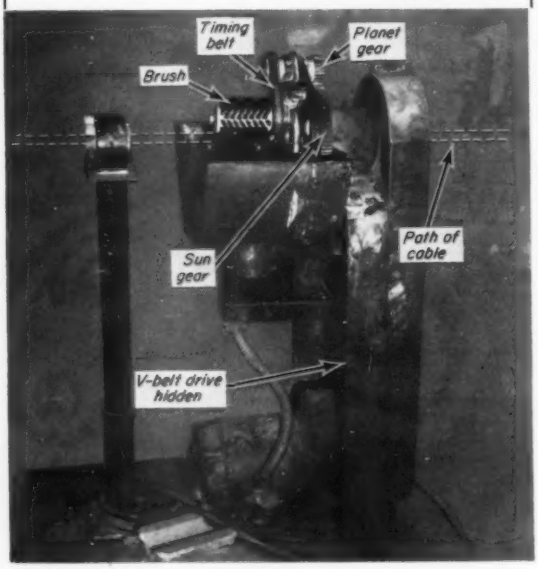
Fast method now uses pair of brushes rotating around cable which is drawn through the machine. Brush-shafts driven by pulleys, are primarily turned by pair of planetary gears rotating in orbit around a large sun gear. The large gear is driven by a V-belt. Power-source is ½-hp, a-c, motor.

For the first trial, chains were used to drive the brushes. The links clogged with debris, causing a braking action which broke gear teeth.

Second trial, using timing belts, was successful. Vibration of belts was a self-cleaning action which kept debris clear.

The cable-cleaning machine is now in operation at *The Okonite Co.* plants, Passaic and North Brunswick, N. J.

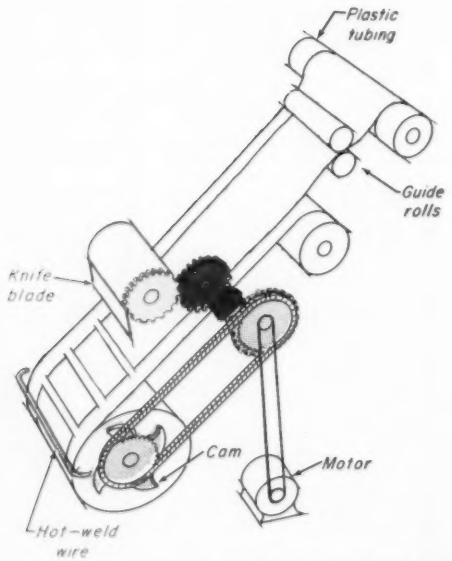




PLANETARY GEARS rotate cable-cleaning brushes, speeding an operation formerly done by hand. Schematic shows gear arrangement seen in photo.

No. 11. For more information on any component in this article, see page 57

Change gears eliminate variable speed sheave



CHANGE GEARS synchronize different speeds from a single motor in a plastic bag plant.

Problem: How to cut bags of various lengths from roll-stock material and keep material going through the machine at the same rate of speed.

This meant the knife would have to cut faster for short 6-inch lengths, slower for long lengths up 12-inches.

Because only a few bag-lengths were needed and production runs were high, a variable speed reducer was too costly.

Solution: Use five change-gears, each of which drive the knife at needed speed to cut various bag lengths.

The result is a high bag-production rate at desired lengths and speeds while conveyor speeds remain constant. Lengths are quickly changed by changing the gears.

The machine is the development of a machine manufacturer in Cincinnati, Ohio.

CHANGE GEAR highlighted in color, varies speed of bag-cutting knife while conveyor speed is constant.

No. 12. For more information on any component in this article, see page 57

continued from page 24

unlike the same curve for the d-c shunt wound motor. Unlike the d-c shunt wound motor, which can be made to operate over a large speed range, the a-c induction motor does not lend itself to speed adjustment without some type of frequency changer. The normal method of obtaining speed changes with a squirrel-cage motor is to use either gears, or sheaves, or both between the motor and load which it is driving. This is considered its greatest disadvantage.

Wound-Rotor Induction Motor

This motor has high starting torque and is the only variable-speed a-c motor available. Speed can be controlled up to a ratio of 2 to 1 or half rated speed. This motor takes advantage of the effect a change in rotor resistance can have on the speed torque curve by making it possible to change rotor resistance. The rotor has a winding which is very similar to the winding of the stator. There are three separate windings on both the rotor and the stator. The stator can be connected in either *delta* or *wye* (tee or star). The rotor is usually connected in *wye*, with the three motor winding leads brought out to three slip rings on the rotor shaft. Brushes make contact with the three slip rings and allow a wye-connected external variable resistance to be inserted. By moving the handle on the controller, it is possible to insert zero external resistance by shorting the three slip rings together; or insert any amount of resistance into each phase of the rotor circuit. If just the right amount of resistance is inserted into the rotor circuit, it is possible to have the motor develop maximum torque at starting.

This optimum resistance can be calculated if the constants of the motor are known by

$$R_2 = \sqrt{R_1^2 + X_e^2} \quad \text{.....(10)}$$

where R_2 = rotor resistance in ohms per phase; R_1 = stator resistance in ohms per phase, and X_e = leakage reactance of the motor in ohms per phase. All refer to the stator winding.

If more than this critical resistance is inserted, the motor will develop less than maximum torque at starting and the speed-torque curve will be a straight line with a negative slope.

As higher and higher values of rotor resistance are used the speed of the motor for a given load will decrease. It is possible, therefore, by inserting different values of rotor resistance to effect some speed control on the wound rotor motor.

Synchronous Motor

This type motor has constant speed at all times, regardless of load. It can also be used for power factor correction in large plants. The equation for speed is the same as that for the speed of the field in the stator of the induction motor

$$\text{rpm} = \frac{120\ f}{P} \quad \text{.....(11)}$$

The motor consists of a stator which is very similar to the stator of the induction motor. It consists of three windings which are displaced 120 degrees. The rotor consists of a winding located on poles which protrude from the shaft. These poles become electro-magnets when d-c current is applied to the rotor through two slip rings on the motor shaft.

The problems of starting a synchronous motor are numerous. A motor starter is usually used. This motor requires a-c, three phase power for the stator, and a d-c for the rotor. This increases cost considerably unless a source of direct current is available.

The basis of operation is quite simple. The rotating field in the stator links with the field in the rotor when d-c current is applied. The north pole of the revolving field attracts the south pole of the rotor. The rotor follows the poles of the stator field around at synchronous speed.

In fact, a synchronous motor operating over-excited and not connected to any load will operate at almost zero power-factor leading, or will have the same effect on the line as a capacitor of equal reactive kilovolt-amperes (kvar) rating. The percent of excitation is controlled by the amount of d-c current flowing through the rotor. The higher the magnitude of rotor current, the higher the percent excitation.

The over-excited synchronous motor is quite often used to drive a constant load, and at the same time correct the overall power-factor. Under ideal circumstances this arrangement can be economical.

continued from page 25

tion in flux. This process continues until the torque is equal to that required by the load, at which speed the motor stops accelerating and continues to operate at constant speed. If the series motor were to operate without load, it would continue to accelerate.

Unlike shunt wound motor which has a very low percent speed regulation, even without controllers, series motor speed regulation is high; in fact it cannot be expressed in the conventional manner since the no load-speed is so high. Every change in load manifests itself in a large change in motor speed.

Since the main advantage of the series motor is its ability to produce maximum torque at starting, it is not advisable to insert additional resistance in the armature circuit for starting. When it is desirable to control starting torque, such as in rail cars, a variable resistance is inserted in the circuit.

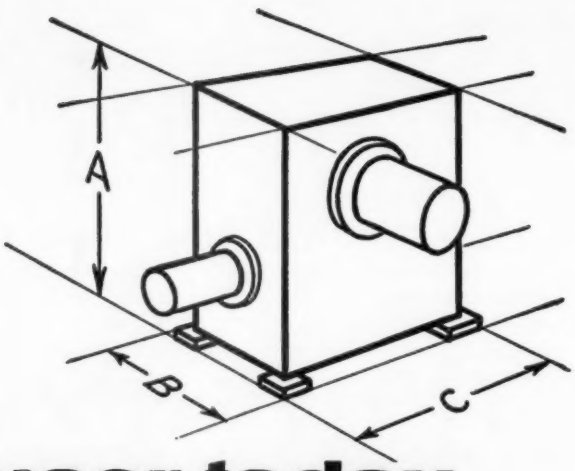
Compound Wound Motor

These motors have desirable variable speed characteristics. They have a shunt field similar to the shunt motor and a series field similar to the series motor. However, a balance is made between the amount of flux produced by the shunt field and that produced by the series field. The series field has fewer turns than the series field in the series motor. Depending on the degree of compounding, the motor will have almost the same characteristics as the other two. The compound wound motor will have a higher starting torque than the shunt wound motor, but it also will have a higher speed regulation.

Comparison between the shunt wound, compound wound, and series motors is shown.

Applications of shunt wound and compound wound are similar. Practically all shunt wound motors have a small amount of compounding built into them for stabilizing effects. The shunt wound and the compound wound lend themselves easily to applications where variable speed is required. Shunt wound and compound wound are the only practical motors capable of efficient speed adjustment. It is very difficult to change speed of a-c motors without sacrificing a great deal in efficiency.

Do-It-Yourself...



Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

Does this reduce load capacity? No sir! You can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

Cone-Drive Gears, that's where!

Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

For more information circle No. 7 on the Reader Service Card

NEW PRODUCTS

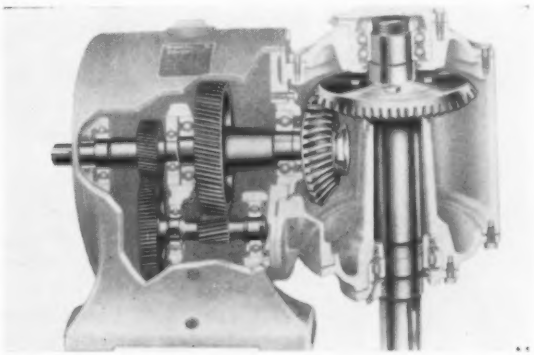
Right-angle head

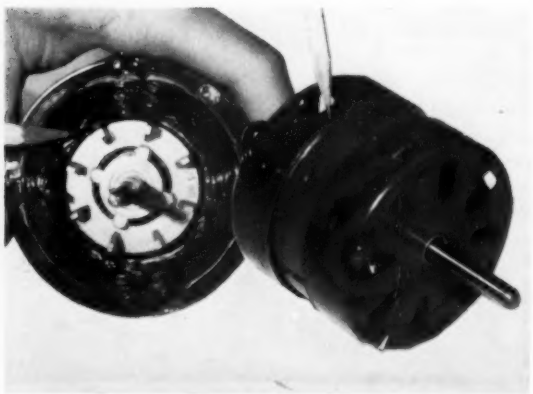
Universal-mounted right-angle head is adaptable to StraightLine speed reducers and gearmotors.

It comes in horizontal, vertical, or intermediate positions with single or double extended shafts. This particular type of head is especially adaptable to specific types of applications where right-angle gear head characteristics are desired. The fact that its positioning is variable is also important.

The head is produced by *Western Gear Corp., Industrial Products Div.*, Belmont, Cal.

Circle No. 200 on the Reader Service Card





Small motors

Air gap in small motors is critical because of its effect on efficiency, starting characteristics, and noise levels. Designers have built these small motors around the best air gap they could calculate. This improves efficiency by as much as 40%. The line is now available in 4-pole, KSM 59-frame, shaded-pole and permanent-split capacitor models up to 1/15-hp.

Bearings are permanently aligned on the motor shaft during assembly. They are supported rigidly by the end shield. Motors are coated with resin to maintain the air-gap's critical dimension.

General Electric Co., Specialty Motor Dept., Fort Wayne, Indiana.

Circle No. 201 on the Reader Service Card

Vertical gearmotors

Internally-geared vertical Syncrogear motors, rated from 3-hp to 30-hp and 25 rpm to 280 rpm, are designed for tough industrial mixing applications, including pigments, chemicals, and clays.

Best known facts about the gearmotors are their design features. These include: lubriscope, oil circulation window, dry-well construction, lubriflush, centrally located service points, dependable oil circulation pump, start-up oil recess, U. S. precision gears, single-unit cast-iron housing, streamlined design for cleanliness, standard A.S.A. pipe-flange mounting, and asbestos-protected windings.

U.S. gears have such special features as elliptoidal design of helical teeth, U.S. solid-shank primary pinion, and through-hardening of teeth.

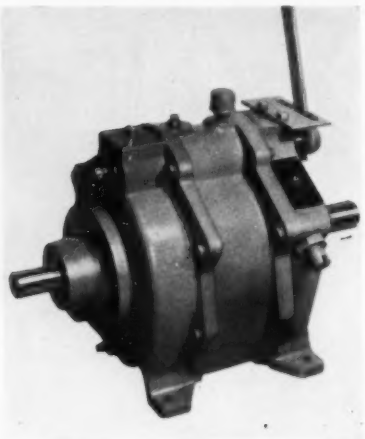
Different methods of speed control are available: a handwheel on the unit, remote mechanical, remote electrical, or Varitrol automatic control. With the last method, the speed of the drive can be adjusted to meet any change in viscosity of the material being mixed.

U. S. Electrical Motors, Inc., Los Angeles, Cal.

Circle No. 202 on the Reader Service Card

Reversing transmission

Small reversing transmission has five speeds: two forward, one neutral, one reverse, and one reduction. It transmits up to 28 hp at a maximum recommended input speed of 2000 rpm. Reduction ratio is 1.97:1 and



3.34:1 in forward, and 3.37:1 in reverse. It is 15-11/16 in long, 14 in wide, 14-¾ in high. It is suggested for agricultural, material handling, machine tool and construction uses.

Snow-Nabstedt Gear Corp., Industrial Div., Hamden, Conn.

Circle number 203 on reader service card

Adjustable-speed drive

Ajusto-Speed drive incorporates a tachometer feedback circuit which continually monitors the drive shaft and automatically corrects speeds as required. Speed is set quickly and precisely by speed-setter knob. Available in ratings from ¾ to 7½ hp.

The Louis Allis Co., Milwaukee, Wis.

Circle number 204 on reader service card

Centrifugal switches

Where precise speed sensing and repetitive accuracy must be maintained over long periods of service, Type C centrifugal switches are superior to other rotating devices. Typical applications include indication of belt slippage, stoppage or breakage; indication of excessive belt slowdown; interlocking of conveyor drives to prevent pile-up of material; prevention of overspeeding of motors, etc.; removal of reverse power when motors are plugged to stop; getting sequential control functions at specific speeds.

The switch contacts are actuated by speed changes of the driving member to which the centrifugal switch is attached. Since the contacts are controlled by centrifugal force, they are not affected by temperature and viscosity changes, eddy current variations, or other environmental conditions that may affect other types of rotating, speed-sensitive devices, the manufacturer claims. Various weight flyweight and spring combinations are available to cover the range of speeds encountered. Overall adjustable speed range is from 70 rpm to 4500 rpm.

Euclid Electric & Mfg. Co., Madison, Ohio.

Circle number 205 on reader service card

Motor starters

Building-block approach to design of 0 to 4 starter line has made possible a simplified series of standard, special, and accessory control devices with many standardized parts. They are available for 100 to 600 v service for motors ranging from fractional to 200 hp. Overload relays are completely trip-free, and can be reset manually or automatically. Field

modification is simple. NEMA Type 1, 4, 5, 7, 9 and 12 enclosures are available. Delivery of standard units varies from immediate to four weeks; delivery of specials is from immediate to eight weeks.

Allis Chalmers Manufacturing Co., Milwaukee, Wis.

Circle number 206 on reader service card

Sprockets in stock

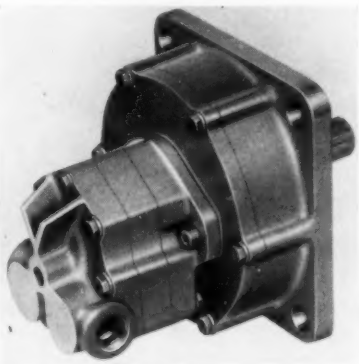
Distributors can reduce inventory, yet carry more than six hundred combinations of pitch, teeth and bore size sprocket assemblies with the Selecta-Bore line. Interchangeable plates and hubs make it possible. Assembled sprockets come ready for installation, complete with standard keyway and setscrew; no reworking is needed.

Whitney Chain Co., Hartford, Conn.

Circle number 207 on reader service card

Hydraulic motor gear reducer

A gear-type fluid motor is mounted as part of a planetary gear reducer in this new unit, designed for driving rotary welding, soldering or heat-treating fixtures; powering hoists,



cranes or rope drives; turning turrets or platforms; or driving elevators or conveyors. Components are designed for 150 ft-lb output torque with 1500 psi oil source. Smooth output even at lowest shaft speeds is claimed. Reduction ratio is 4.6:1.

Webster Electric Co., Racine, Wis.

Circle number 208 on reader service card

Load-demand system

FAC-100, for use with electric plants up to 4500 watts, automatically starts the electric plant when equipment is switched on, and turns the power off when it's not needed. Used with an automatic line transfer switch it serves as a standby monitor, turning on the plant system when public power fails and shutting it off automatically when power is restored.

Pacific Mercury, Van Nuys, Calif.

Circle number 209 on reader service card

Right-angle power transfer

Hardened steel spiral gears, non-magnetic stainless steel shafts, and double-sealed, hardened and ground ball bearings are among design improvements in expanded line of right-angle power transfer units, which now includes 17 models. Manufac-

turer says changes mean quieter operation, longer life and higher capacity. The line comes in a completely enclosed 356 aluminum alloy mounting, with a choice of four or five mounting positions, and two or three shaft extensions. Ratios may be 1:1 or 2:1. Power ratings are from 1.4 to 2 hp.

Crown Gear, Worcester, Mass.

Circle number 210 on reader service card

Traction equalizer

When one wheel of a vehicle tends to turn faster than the other wheel on the same axle, indicating a loss of traction, this device increases power to the more effective wheel. It's continually engaged, so is automatically effective without any action on the part of the driver. With multi-drive axle vehicles, one equalizer may be installed for each axle.

Rockwell-Standard Corp., Transmission and Axle Div., Detroit, Mich.

Circle number 211 on reader service card

Magnetic clutch

Practically no maintenance and higher output are two advantages of new EC-S series magnetic clutches. The design incorporates a closed flux path through hardened steel laminations, eliminating the need for adjusting air gaps. It also uses a sta-

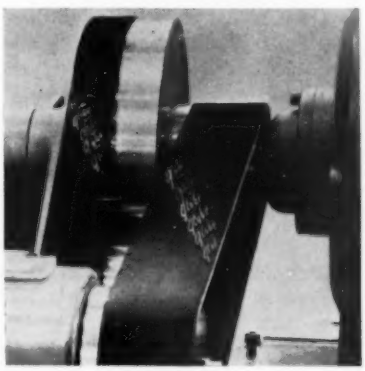
tionary magnetic field with coil windings on the stator rather than rotor, eliminating slip rings and brushes. Present line includes five sizes, with output from 14 to 290 lb-ft, but expansion to 12 ratings is planned during the next few months. Clutches available from stock operate off 24 or 90 v dc.

I-T-E Circuit Breaker Co., Philadelphia, Pa.

Circle number 212 on reader service card

Versatile endless belts

Flat transmission belts for all speeds and loads. Hi-Speed 400 belts are uniformly constructed to equalize stress and eliminate vibration. Bonded



for friction-free service even at highest speeds. Pre-stretched in manufacture for maximum stability, but with enough flexibility to maintain tension at whatever load and speed. Specially designed for high pulley speeds and reverse action of small diameter pulleys.

Globe Woven Belting Co., Inc., Buffalo, N. Y.

Circle number 213 on reader service card

Magnetic motor starter

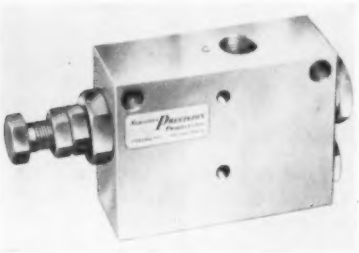
New NEMA Size 2 magnetic motor starter is 34 percent smaller than previous open forms and 14 percent smaller than previous enclosed forms. No tools are needed for routine inspection, and contacts can be inspected or the coil changed from the front in about 10 seconds. Overload-relays are designed so starter contacts cannot be held closed during overload conditions and cause damage to the motor. Motor rating: 25 hp at 440/600 volts.

General Electric Co., Schenectady, N. Y.

Circle number 214 on reader service card

Holding valve

New valve locks a hydraulic motor when no motion is wanted; prevents load from running ahead of the oil supply when the load is being moved; relieves excessive pressure generated in the motor by the load and permits the load to be moved manually if



power fails. It uses little or no power when the load is being moved, and is said to be quieter and smoother than a conventional seated-ball pilot check valve. Pressure rating is 3000 psi.

Sarasota Precision Products, Inc., Sarasota, Fla.

Circle number 215 on reader service card

Airborne motor

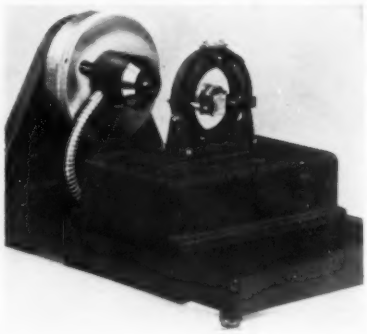
Model D-820 d-c motor operates off 28-volt supply, delivers 2-hp at 3000 rpm. Its normal operating range is from 0.8 hp to 3-hp. The motor, designed for aircraft, missile, ordnance, marine and industrial installations, is a rugged, lightweight power unit, with integral cooling fan and long-life, easily accessible, high-altitude brushes.

Hoover Electric Co., Columbus, Ohio.

Circle number 216 on reader service card

Rotor balancer

New photoelectric pickup, designed especially to scan outside race rotors and assemblies with concealed or stationary shafts, makes it possible to dynamically balance high-speed motor armatures as small as 7 grams. It will also accommodate gyros up to 32 oz and 2⅛ in. O.D. The balancer



can measure rotor displacements as small as 0.3 microinch at speeds from 1000 to 200,000 rpm. It mounts on a bench, requires 10 x 15 in. of space.

M. Ten Bosch, Inc., Product Application and Sales Dept., Pleasantville, N. Y.

Circle number 217 on reader service card

Intermittent drive unit

Completely packaged unit provides precise intermittent motion from constant source of rotary power. Compact size allows it to be installed on existing equipment, designed into new machinery, or re-used after production line changes. Combines precise control of any set of motions, such as clip and bend, shear or slash, oscillate or repeat, raise or lower, index and position. All parts totally enclosed in an oil bath housing. Manual, mechanical or electrical control for operations in fixed or variable cycles. Unit needs only electrical connection.

Hilliard Corp., Elmira, N. Y.

Circle number 218 on reader service card

Head pulleys

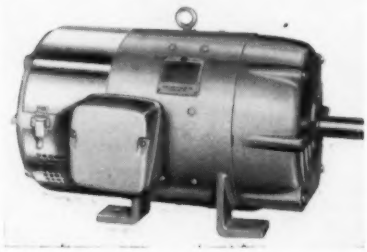
New head pulley makes up a self-contained package, with motor, reduction gears and all other moving parts inside the pulley. It weighs less than conventional drive assemblies, so makes possible lighter supports. It requires no more room than a regular idler pulley, so is recommended for use in tunnels, or around chutes or hoppers where there isn't much headroom. Easily installed or moved from one conveyor to another. Standard sizes range from 1 to 125 hp; sizes to 250 hp are available on special order.

Western Conveyor Co., Boise, Idaho.

Circle number 219 on reader service card

DC motors

Flexitorq dc motors are said to give faster response, wider speed range and higher overload capacity in a lighter, smaller machine. They come in ratings of 1 to 200 hp, in drip-proof guarded enclosures. Low-inertia



armature and improved commutation are claimed to give faster acceleration, deceleration, reversing and speed changing.

The Louis Allis Co., Milwaukee, Wis.

Circle number 220 on reader service card

Crane-hoist motors

High-slip, high-torque characteristics enable these crane-hoist motors to give smooth starts with heavy loads. Made especially for material handling applications, they are said to cost less than standard motors, and are available for original and replacement installations. Ratings are from

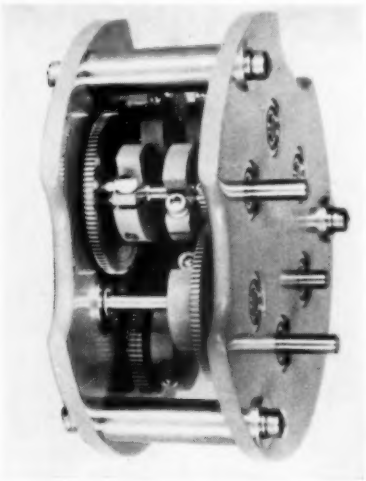
½ to 50 hp, for 15 or 30-min duty; frame sizes are from 182 to 365U.

Reuland Electric Co., Alhambra, Calif.

Circle number 221 on reader service card

Precision gear box

For use in servo and instrument applications, this gear box gives a choice of reductions from 1:1 to 3125:1. An almost unlimited number of gearing configurations may



be assembled from stock components. The gear box is made of anodized aluminum alloy and stainless steel, meeting the requirements of military specification MIL-E-5400. Its diameter is 2.875 in. and length is 1.090. in. Gears are AGMA Precision 1 or better; ball bearings are ABEC 7 double shielded. Zero backlash is available in all ratios.

Precision Mechanisms Corp., East Meadow, N. Y.

Circle number 222 on reader service card

Small airborne turbine engines

General Electric's T-58 turboshaft engine, designed for lightweight, high-performance aircraft, delivers 1050 shaft hp with a specific fuel consumption of 0.64. The engine weighs 271 lb. The military services are testing it in the North American T-39 and Northrop T-38 trainers and the McDonnell GAM-72 decoy missile.

Another new GE powerplant, the T-64 turboshaft/turboprop, is in the 2600-hp class and has a better than 3-to-1 power-to-weight ratio. It's intended for heavy-duty helicopters, convertiplanes, vertical takeoff and landing aircraft, short takeoff and landing aircraft, and conventional aircraft.

General Electric Co., Small Aircraft Engine Dept., Lynn, Mass.

Circle number 223 on reader service card

TIC names new vice president general manager, director

ACTON, MASS.—At a recent meeting of the board of directors of Technology Instrument Corporation, three new appointments were made.

George E. Pihl was named vice president in charge of engineering for the corporation and all subsidiaries. He had formerly held the same post for Acton Laboratories, a company subsidiary.

PIHL

BURNS

Elmer F. Burns is the new general manager of the company, having been plant manager since 1956. Prior to 1956, he had been general manager of TIC's Servotrol subsidiary, Chicago.

New member of TIC's board of directors is Harvey Bishop. Mr. Bishop is assistant dean of the Harvard Graduate School of Business Administration.

Norris becomes production head at U. S. Rubber

NEW YORK, N. Y.—Howard K. Norris is the new production manager of the mechanical goods division of United States Rubber Co.

Operating from the company's offices at Rockefeller Center, Mr. Norris will supervise plant production and product development at the Philadelphia, Passaic, N. J. and Sandy Hook, Conn. plants.

Mr. Norris joined U. S. Rubber's tire sales department in 1940. He became assistant factory manager of the company's Gilmer plant in Philadelphia in 1953, and factory manager in 1957. In this capacity he supervised the inception of several additional production lines in the company's power transmission field.

New Warner engineering head

BELOIT, WISC.—Robert A. Heath is the new manager of engineering at the Warner Electric Brake & Clutch Company in Beloit. Announcement was made by E. A. Cleary, vice president of operation.

Woods adds four in field sales

KUHN

STUARD

HAMILTON

LAMBERTON

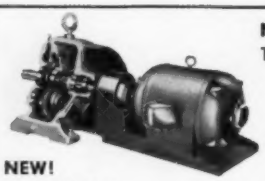
CHAMBERSBURG, PA.—T. B. Wood's Sons Co. has appointed field sales engineers for the Detroit, Philadelphia, Houston and Atlanta districts.

George W. Kuhn, formerly field sales engineer in Central Pennsylvania and Maryland, transfers to the Michigan territory.

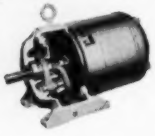
Samuel S. Stuard, former district manager in Philadelphia for The American Pulley Co., becomes Wood's field sales engineer in Philadelphia.

David C. Hamilton, former Dayton Rubber Co. district manager in Dallas, joins Wood's Houston operations.

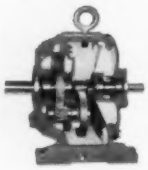
George M. Lamberton will represent the company in Atlanta. Previously he was with the Worthington Corp. Atlanta sales office.



NEW! Jones Integral Type Gearmotors

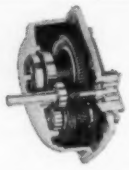


NEW! Jones All-Motor Type Gearmotors



Designed with high-hardness gearing for longer life. One-piece low speed end housing construction insures gear alignment and prevents oil leakage. Compact design. All three types available for foot-mounted or flange-mounted installation, and for horizontal or vertical application. Capacity is up to 250 hp.

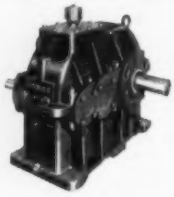
NEW! Jones In-Line Helical Reducers



NEW! Jones Shaft-Mounted Reducers

High-hardness gearing gives compact design and extra service life. Positive sealing against oil leakage through double lip type seals. All gearing straddle-mounted between anti-friction bearings. Single and double reduction units to 40 hp. Six standard sizes. Flange-mounted units available in three standard sizes.

Now!



Jones Herringbone Gear Reducers

Accepted throughout industry; balanced design, heavy-duty roller bearings, rugged cast iron housing for reliable service and low maintenance costs. The most complete parallel shaft line in industry.

Jones Worm Gear Reducers

Horizontal and vertical shaft types available with ratios to 80:1. Heavy-duty roller bearings throughout with high-test cast iron housings for positive gear alignment.

Jones Worm Helical Reducers

For vertical output shaft service; ratios from 25.63:1 to 357.5:1. Provide optimum combination of initial cost, efficiency, and low maintenance. Proven in hundreds of installations; redesigned to incorporate latest improvements in metallurgy and reducer design.

Jones Speed Reducers for every purpose

One of the most comprehensive speed reducer lines in industry! With new shaft-mounted reducers, in-line helical reducers, and gearmotors, Jones now offers a wide selection for all your power transmission needs. New technical literature gives you exactly the information you need for proper selection of units in accordance with latest A.G.M.A. ratings. Be sure to ask your Jones representative for copies, or write Hewitt-Robins, Stamford, Connecticut. Ask for Bulletin 6-22.

HR HEWITT-ROBINS

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INDUSTRIAL HOSE ... VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

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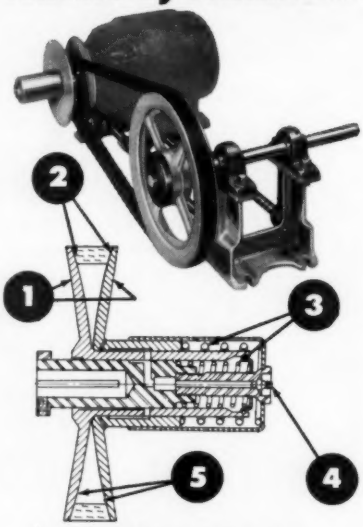
For more information circle No. 13 on the Reader Service Card

feature by feature...



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1. Both sides of the driving disk open simultaneously and equally to give constant belt alignment.
2. Power is transmitted through sides of the belt to a grooved sheave to insure maximum efficiency and prevent slippage.
3. Each side of the driving disk is independently actuated by its own spring, eliminating ratchets, cogs, gears or other moving parts subject to constant maintenance and wear.
4. Oilite bronze bushings on fractional hp. units provide life-time lubrication.
5. Curved pulley faces maintain full contact with belt sides at all times, greatly increasing overall efficiency.

Pulleys are available in a complete range of sizes, fractional to 15 hp.—full 3 to 1 ratio. Immediate delivery from stock.

Request recommendations for your application. Ask for Catalog P-58.

Lovejoy *FIRST NAME IN VARIABLE SPEED PULLEYS*

LOVEJOY FLEXIBLE COUPLING CO.

4852 West Lake Street, Chicago 44, Illinois
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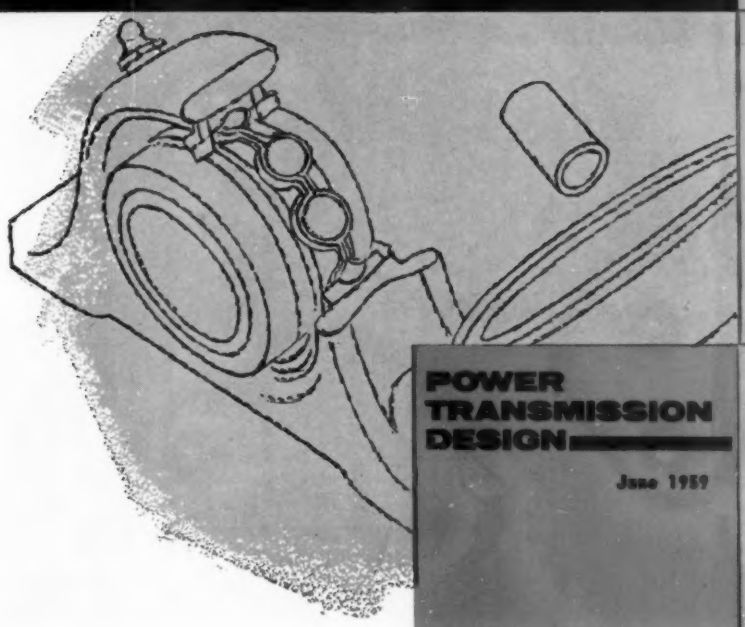
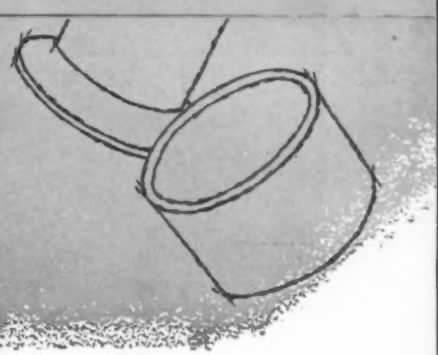
Circle No. 17 on Reader Service Card

BEARINGS

DESIGN/APPLICATION



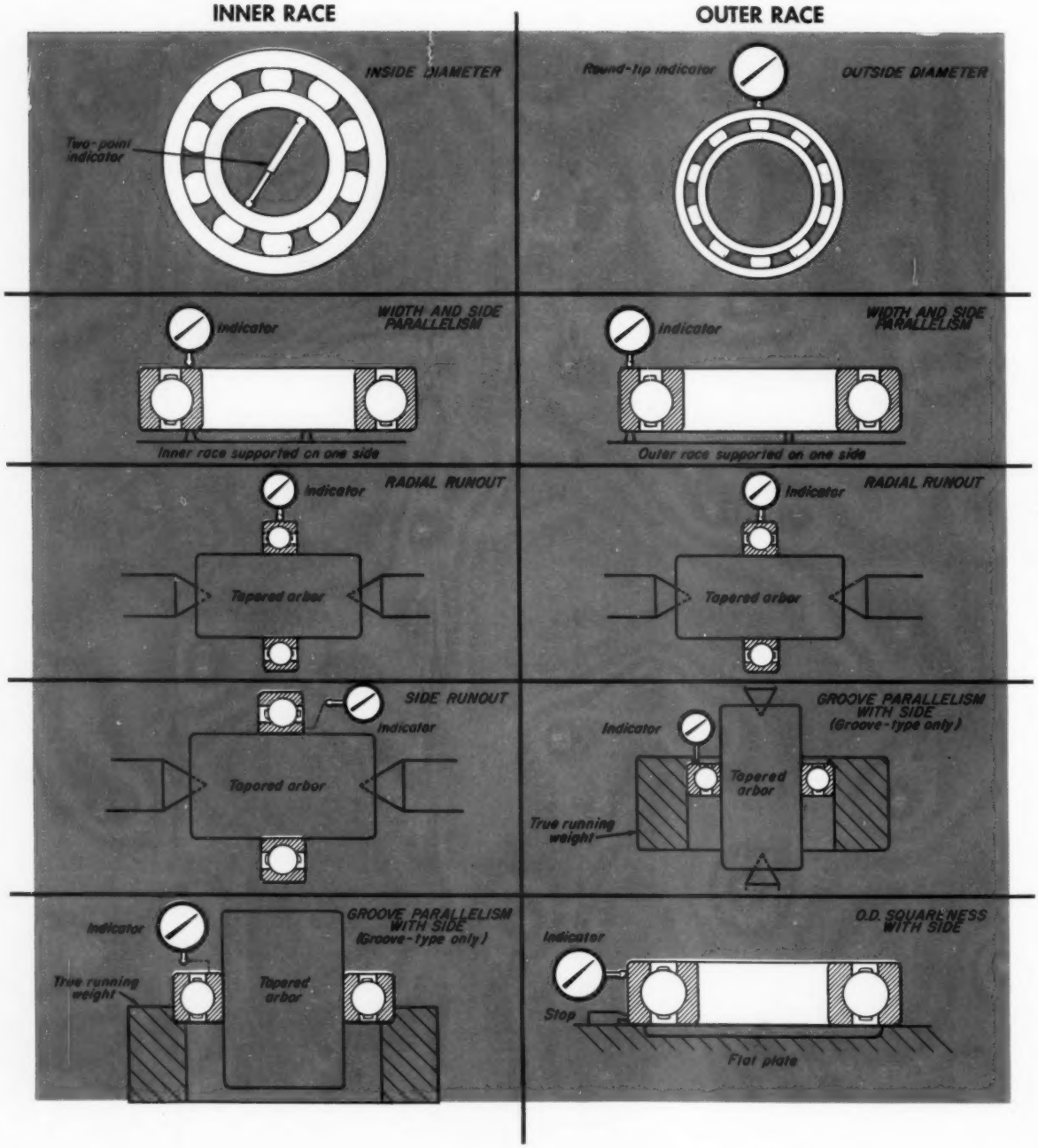
REGULAR MONTHLY SECTION OF IDEAS AND DEVELOPMENTS



POWER TRANSMISSION DESIGN

June 1959

Too many maintenance overhauls call for new bearings throughout. This is costly and usually not necessary. To stop this, you can check bearing measurements against manufacturer's specifications and separate good from bad by knowing . . .



How to check ball bearing measurements

Don't throw away good ball bearings. Long hours and sustained operation do not mean bearings are worn out. Check them. Here's a way to do it if you do not already have a standard method. This is the AFBMA (Anti-Friction Bearing Manufacturer's Association) standard system. However, if your inspection and production departments have a method that is satisfactory, use it.

These standards conform to those used by the National Bureau of Standards in Washington, D. C. and are to be used at a constant temperature of 68 F. Do your measuring only after the bearings and gaging equipment have stabilized at this temperature. House your equipment in a special room, usually called a "cold room." Standard gaging loads are shown in the tables below.

How to Check Inner Race

To check the bore, use a two-point measuring instrument. If out-of-roundness and taper exist, a minimum reading d_{min} and a maximum reading d_{max} will show up. The actual bore diameter, d_m is the average of the two. Large diameter bearings with thin races should be placed in a horizontal position when measuring.

To check width, support the inner race on one side by three buttons. Let the outer race free to rotate. Apply a calibrated dial indicator against the opposite side of inner race directly over one button. Take reading while rotating the race. Width tolerances apply only to one race at a time and not to total width of the bearing.

To check parallelism of sides, support the inner race on one side by three buttons. Let the outer race be free to rotate. Apply a calibrated dial indicator against opposite side of inner race directly over one button and take reading while rotating the race. Deviation from parallelism is the difference between the largest and smallest width readings.

To check radial runout, mount bearing on arbor with a very slight taper (0.0001 to .0002 in. on the diameter per inch of length). Apply a calibrated dial indicator at the center of the stationary outer race. Radial runout is the difference between the minimum and maximum readings when rotating the arbor one revolution. Corrections should be made for inaccuracy of the arbor.

To check side runout, mount the bearing on an arbor having a very slight taper (0.0001 to 0.0002 in. on the diameter per inch of length). Apply calibrated dial indicator against side of inner race. Side runout is the difference between the maximum and minimum reading when rotating the arbor one revolution.

To check groove parallelism with side, mount the bearing on an arbor having a very slight taper

Continued on page 58

Table 1 Gauge loads for inner and outer races

	NOMINAL DIAMETER		GAUGE LOAD	GAUGE POINT RADIUS
	OVER	INCLUDING		
INNER RACE (Bore)	0 mm	9 mm	Not exceeding 7 ozs	0.8 mm = 0.032"
	9 mm	30 mm	Not exceeding 7 ozs	2.5 mm = 0.098"
	30 mm and over		12 ozs	2.5 mm = 0.098"
OUTER RACE (OD)	0 and up		Not exceeding 7 ozs	2.5 mm = 0.098"

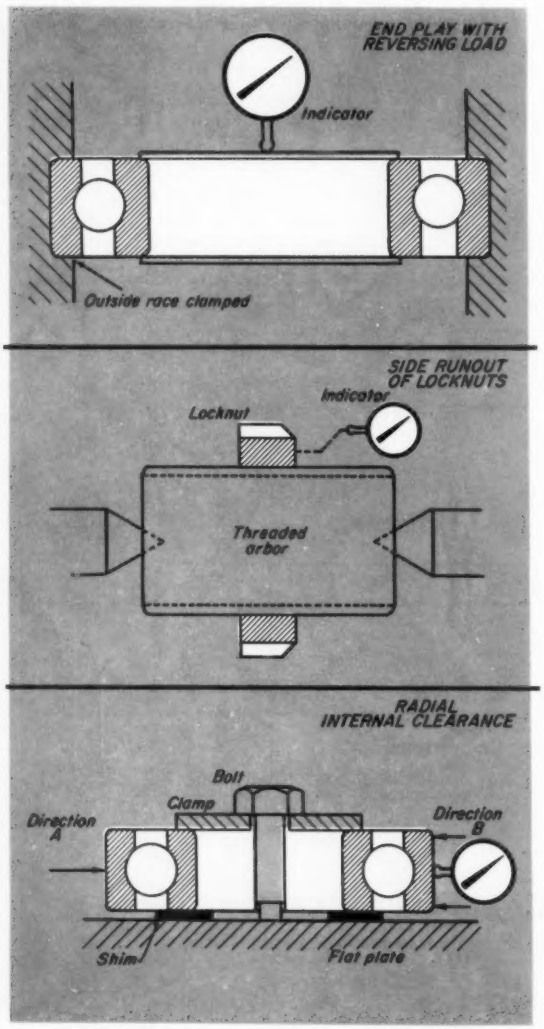
Table 2 Gauge loads measuring end play

EFFECTIVE GAUGE LOAD	FOR BEARINGS WITH OUTER DIAMETER·····
2-1/2 kg or 5-1/2 lbs	··· Over 0 mm to and including 50 mm
5 kg or 11 lbs	··· Over 50 mm to and including 120 mm
10 kg or 22 lbs	··· Over 120 mm to and including 200 mm
20 kg or 44 lbs	··· Over 200 mm

How to measure radial internal clearance

MANY COMPANIES MEASURE bearing looseness by determining the amount of end play. Some measure looseness radially. The latter is more correct because it is not disturbed by variations in the groove radii of both races. Radial play, as a rule, is of greater significance than axial play.

It is not easy to measure the internal looseness precisely in a single row bearing. Different types of gages give different results. In order to overcome these difficulties and make it possible to determine if bearings are within standard tolerances, without resorting to special expensive gages, a more simple method is used with equipment which is readily available in any well-equipped shop.



It is realized by The Anti-Friction Bearing Manufacturers Association that any simplified method might not be practical when checking large numbers of bearings. On the other hand, if the method is dependable and gives accurate values, no question can arise on the magnitude of looseness.

Those who prefer to use a particular type of gage for the sake of saving time may do so by calibrating this gage with bearings whose looseness has previously been determined by the standard simplified method. The Standard Method constitutes the reference base where a difference of opinion or dispute exists.

How to Measure

Fasten the inner race on a horizontal flat plate with a shim (piece of ordinary writing paper 0.002 in. to 0.003 in. thick when handling small bearings, and two or three when handling large bearings) between the race and the plate.

Apply a sensitive dial indicator against the centerline of the ball groove. Hold the outer ring in contact with the rest of the bearing in direction A (see drawing below) with care not to lift the opposite side, and move repeatedly up and down at this one point; oscillate circumferentially (for the purpose of moving the ball to the bottom of the ball groove) until the indicator can be seen to give a generally maximum reading.

While continuing to hold the outer race gently in contact with the rest of the bearing in direction A, move the outer ring at this point first up and then down without circumferential motion. When the balls pass through the bottom of the grooves, the indicator will show a maximum reading, which is recorded.

Without changing the general location of the outer race, hold it in contact with the rest of the bearing in direction B with care not to lift the opposite side, and move repeatedly at this point up and down and oscillate circumferentially a small amount (for the purpose of moving the balls of the opposite side to the bottoms of the ball grooves) until the indicator can be seen to give a generally minimum reading.

Then, while continuing to hold the outer race gently in contact with the rest of the bearing in direction B, move the outer race at this point first up and then down without circumferential motion. When the balls pass through the bottoms of the grooves, the indicator will show a minimum reading, which is recorded. The difference between the two

readings is the radial looseness.

To compensate for possible out-of-roundness of the outer race, repeat the same procedure several times at different angular positions of the outer ring in relation to the indicator. To compensate for possible out-of-roundness of the inner race, repeat the same procedure with this race at different angular positions in relation to the indicator. Take the average of the several readings as the looseness of the bearing.

If the indicator needle does not pass through a clear maximum or minimum reading, respectively, the shim is probably too thin.

When handling large and heavy bearings, insert three pieces of flat stock, each about 1/2 in. thick, between the flat plate and both bearing races. These pieces should be located radially with two of them relatively close together, one at each side of the indicator point, and the third directly opposite the indicator. The paper shims in this case are placed between the inner race and these pieces.

When handling small bearings use a rubber tipped stick for moving the outer race.

To check end play, lubricate the bearing with light oil and clamp one of the races to prevent axial movement. Apply the specified reversing gaging load to the unclamped race so that movement of the race is parallel to the bearing axis. End play is the total movement of the unclamped race when the load is applied first in one direction and then in the other.

How to Check Lock Nut Side Runout

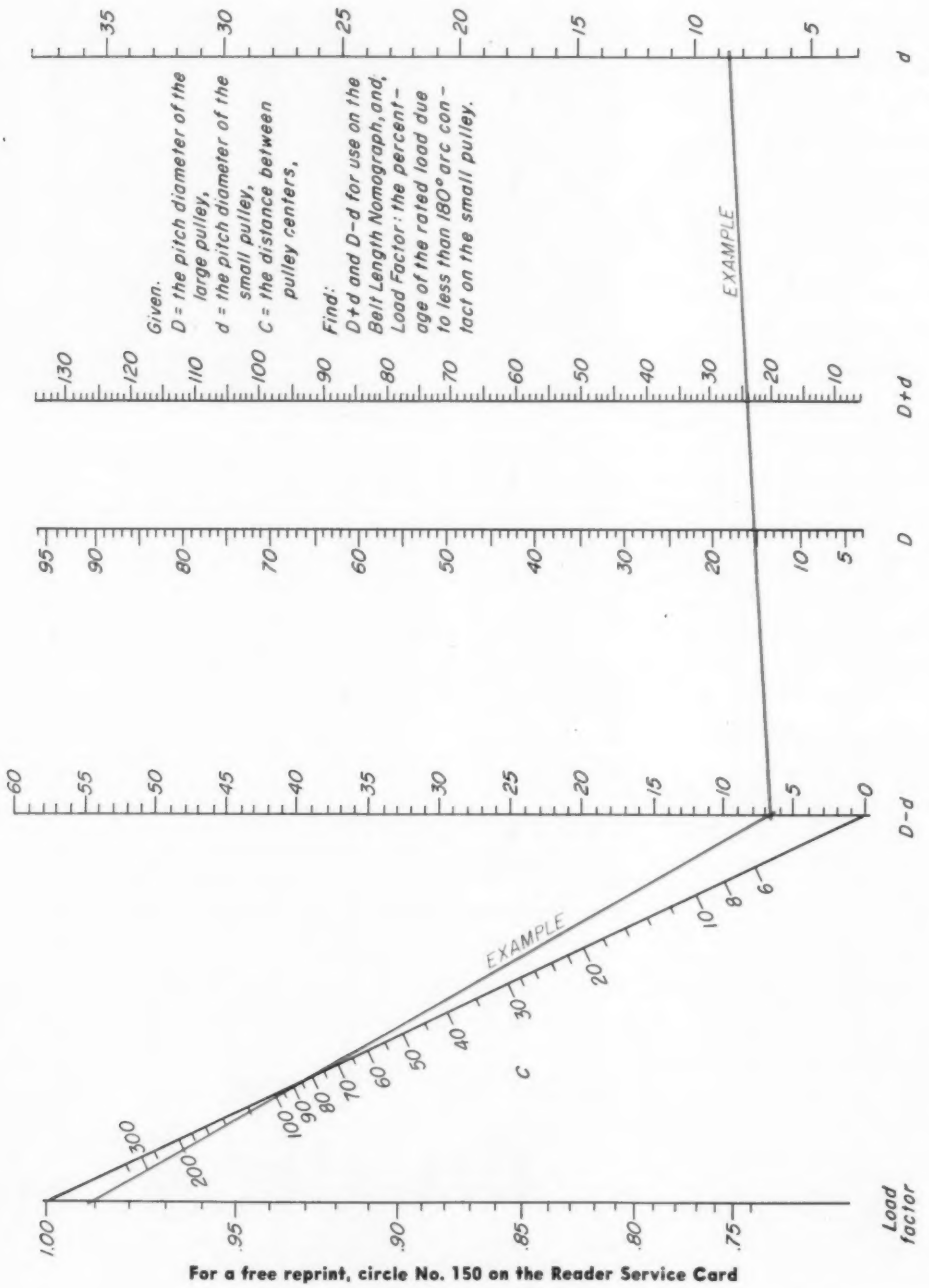
Mount the lock nut on a tight-fitting threaded arbor. A tapered arbor is not acceptable. Apply the calibrated dial indicator against the contact or chamfer side of the lock nut. Side runout is the difference between the maximum and minimum reading when rotating the arbor one revolution. Any part of the surface must be within the tolerance specified in AFBMA Standard Section 3, Table 3-10b.

This article adapted from Ball and Roller Bearing Standard Gaging Practices, Section 4, Standards for Ball and Roller Bearings and Steel Balls, published by The Anti-Friction Bearing Manufacturers Association, Inc., New York 17, New York.

Nomogram A:

How to compute pulley or sprocket center distance

By GEORGE B. RICHTER, *University of Minnesota*



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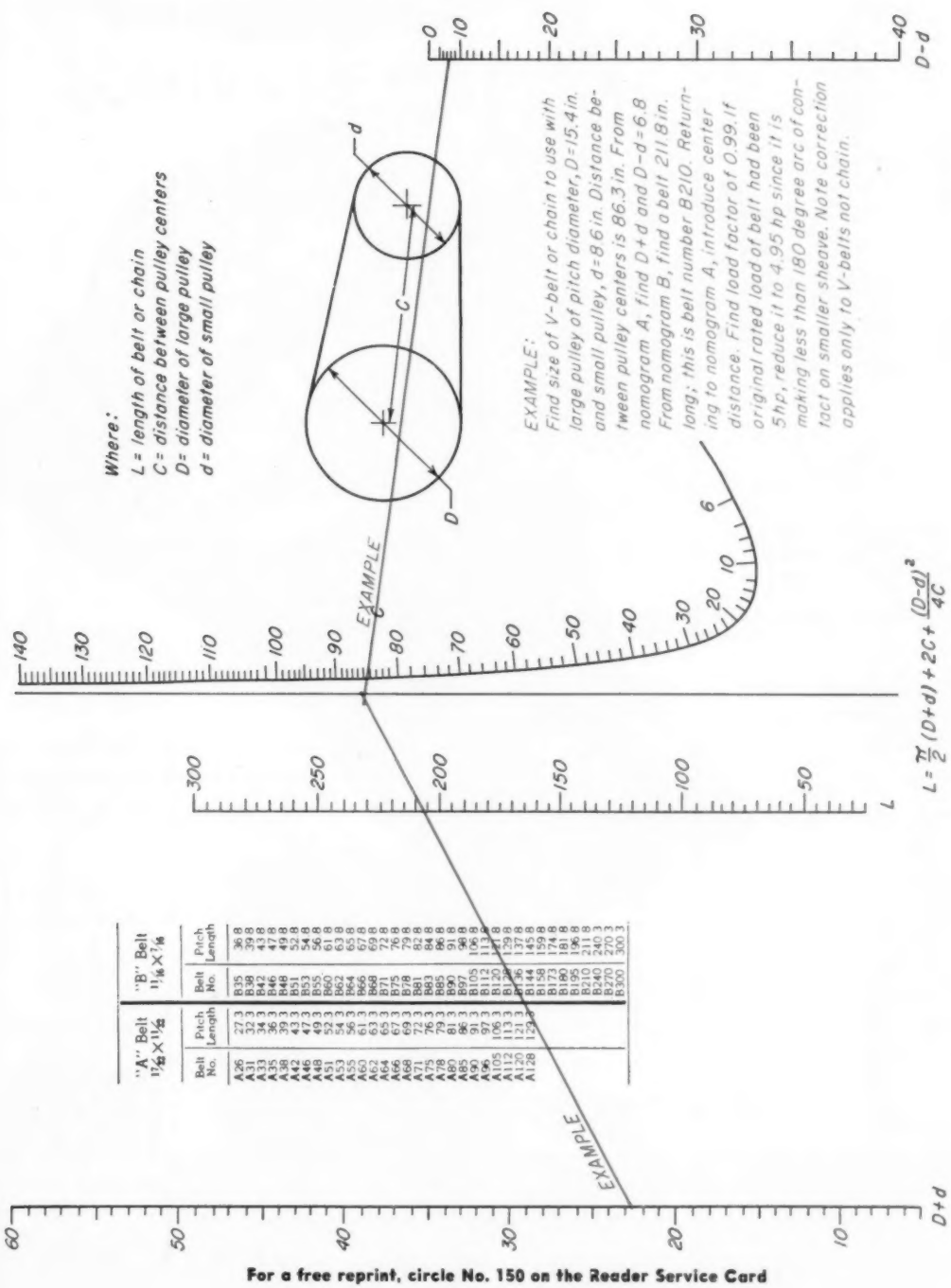
Nomogram B:

How to compute belt or chain length



"A" Belt 1/2 × 11/32		"B" Belt 11/16 × 7/16	
Belt No.	Pitch Length	Belt No.	Pitch Length
A26	27.3	B35	36.8
A31	32.3	B38	39.8
A33	34.3	B42	43.8
A35	36.3	B46	47.8
A38	39.3	B48	49.8
A42	43.3	B51	52.8
A46	47.3	B53	54.8
A48	49.3	B55	56.8
A51	52.3	B60	61.8
A53	54.3	B62	63.8
A55	56.3	B64	65.8
A60	61.3	B66	67.8
A62	63.3	B68	69.8
A64	65.3	B71	72.8
A66	67.3	B75	76.8
A68	69.3	B78	79.8
A71	72.3	B81	82.8
A75	76.3	B83	84.8
A78	79.3	B85	86.8
A80	81.3	B90	91.8
A85	86.3	B97	98.8
A90	91.3	B105	106.8
A96	97.3	B112	113.8
A105	106.3	B120	121.8
A112	113.3	B128	129.8
A120	121.3	B136	137.8
A128	129.3	B144	145.8
		B158	159.8
		B173	174.8
		B180	181.8
		B195	196.8
		B210	211.8
		B240	241.3
		B270	270.3
		B300	300.3

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MRC PILLOW BLOCKS and FLANGE UNITS with *Labri-Seal® BALL BEARINGS

NEW MRC *Labri-Seals*®

combine the advantages of

- **→ a rotating flinger**
- **→ labyrinth seal**
- **→ and positive contact synthetic rubber seal.**

Their efficiency in keeping grease in and dirt out has been proven in many environments involving extremes in dirt and moisture.

MRC *Labri-Seal*® ball bearings are pre-lubricated at assembly eliminating any need for further lubrication.

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PERMANENTLY LUBRICATED
POSITIVELY LOCKING
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Write OUR Engineering Department regarding YOUR bearing problems

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MRC
BALL AND ROLLER
bearings

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continued from page 15

Burnished

This is a method of improving already-generated gears before hardening by rolling them between hardened master gears to iron out inequalities in the tooth surfaces. Burnishing tools with or without a gear shape can be used.

Injection molded

Usually non-metals, such as plastics, nylon and others are used. Finished gears are produced in one operation. Granular material is heated in a cylinder above 400 F and forced into mold under high pressure (20,000 psi and over).

Punched

This is probably the fastest and least costly method. However, it does not have a high degree of accuracy and is limited to narrow face gears. A punching die comes down on flat metal and forms the gear by pushing it through the solid material. It can be done with or without a center hole. Punched gears are often mated with pinions having wider faces.

Lapped

This is a finishing process used to improve the surfaces of hardened gears. It is done two ways: by running two or more gears together with lapping compound to mate them. The other is to use one or more gearlike lapping tools to lightly polish the tooth surfaces.

Sintered

A process of pouring powdered metal into a die and applying high pressure. The metal compacts into a gearlike briquette with little strength. It is placed in an oven which fuses the particles together which provides strength. Gears are porous because of the granular structure of the particles. For greater strength sintered gears are often compressed about 25% with a punch and forming die.

LITERATURE *on drives and components*

Crown gear units

Bulletin 592 illustrates packaged crown gear units for right-angle power transfer. Seventeen models are described, including two-and three-way units with ratios of 1:1 and 2:1.

Crown Gear, Worcester, Mass.

Circle number 100 on reader service card

Electric brakes and clutches

Simplatrol series of electric brakes and clutches are of single friction type, free of sliding parts. They are delivered ready for installation without machining. Two brochures—one for miniature and small units, the other for larger units—illustrate models, give technical data and dimensions.

Simplatrol Products Corp., Worcester, Mass.

Circle number 101 on reader service card

Power transmission castings

Booklet illustrates company's steel castings, including sheaves, gears, pinions, and conveyor parts.

Farrell-Cheek Steel Co., Sandusky, Ohio.

Circle number 102 on reader service card

Gear facilities

Brochure shows company's facilities and illustrates some typical gear products it makes.

Charles E. Crofoot Gear Corp., South Easton, Mass.

Circle number 103 on reader service card

Non-stretch belting

Nycor flat belting, which consists of chrome leather faces bonded to laminated plastic core, is said to be made stretchless in processing, eliminating take-ups. Other features: high tensile strength; narrower belt widths; high speed capabilities; shock-, oil-, and water-resistance; long life. Brochure gives technical data.

Graton & Knight Co., Inc., Worcester, Mass.

Circle number 104 on reader service card

AC drive motor

Data sheet tabulates complete line of —55 to 85 C missile quality ac drive motors; it lists size, voltage, frequency, phases, no-load speed, capacitor rating, running current, power input and output, weight, and gear ratio.

John Oster Manufacturing Co., Avionic Div., Racine, Wis.

Circle number 105 on reader service card

Flexible couplings

Condensed engineering catalog 51-A has 32 meaty pages illustrating complete line of all-metal flexible couplings for diesel engines and marine, industrial and heavy industry applications. Complete engineering information for selection of correct couplings is included, as are photos of the various couplings and pictures of individual applications.

Thomas Flexible Coupling Co., Warren, Pa.

Circle number 106 on reader service card

Automatic assembly

Techniques for automatic assembly of various types of products are illustrated in 8-page bulletin 601 from company which offers automation consulting service, and designs and builds automatic assembly equipment, including index tables, transfer machines and clutch-brake transmitters.

Ferguson Machine Corp., St. Louis, Mo.

Circle number 107 on reader service card

Nonferrous centrifugal castings

Poster size bulletin 157 lists specifications, composition, and physical properties of various copper-based alloys for centrifugal casting of bearings, bushings, shaft sleeves, cylinder liners, rings, etc., and illustrates typical centrifugally cast parts.

Centrifugally Cast Products Div., Shenango Furnace Co., Dover, Ohio.

Circle number 108 on reader service card

AC adjustable-speed drive

Eight-page bulletin 34-200 is all about the VarEPack, ac adjustable-speed drive. It operates directly from ac and permits speeds to be selected or changed while equipment is idle or in motion.

Electric Products Co., Cleveland, Ohio

Circle number 109 on reader service card

V-belt drives

"The Modern Way to Design V-Belt Drives" is a 32-page catalog giving complete drive design information for the use of the Super HC V-belt drive. It includes drive tables and tips on selection and determination of service life. Ask for Catalog DH-900.

Gates Rubber Co., Denver, Colo.

Circle number 110 on reader service card

Collar-lock bearings

Four-page catalog 4 has illustrations, dimensional data and load ratings for collar-lock machine unit ball bearings. These bearings are designed for easy adaptation to all types of housings requiring self-contained ball bearings.

Hoover Ball and Bearing Co., Ann Arbor, Mich.

Circle number 111 on reader service card

Synchronous motors

Bulletin GEA-6814, four-pages, describes in text and illustrations the design features, construction and applications of constant-speed motors for commercial and industrial use.

General Electric Co., Medium AC Motor and Generator Dept., Schenectady, N. Y.

Circle number 112 on reader service card

FACTS AT YOUR FINGERTIPS

Your source for copies of any item mentioned in these pages is as close as the Reader Service Cards bound into this issue. Fill them out and mail: no postage needed.

Gearing sourcebook

Extremely detailed and complete 140-page illustrated catalog gives all information needed to specify and order wide variety of parts. Full specification of gears, bearings, couplings, pulleys, sprockets and others. Helpful conversion tables and application hints.

Chicago Gear Works, Chicago, Illinois.

Circle number 113 on reader service card

Heavy-load bearings

Super Max high capacity ball bearings, especially for heavy radial-load use, are described in a concise, 4-page illustrated bulletin 107. Bearings for combined thrust and radial loads are included, with specific series and styles well outlined.

Hoover Ball and Bearing Co., Ann Arbor, Mich.

Circle number 114 on reader service card

Stock gear line

Compact 140-page catalog, well illustrated, gives data on all standard types of gearing. Copious engineering data and tables, and useful standards and tolerance information are included. Catalog 58.

Globe Gear Co., Globe Stock Gear Div., Philadelphia, Pa.

Circle number 115 on reader service card

New clutch-pulley unit

Magnetic clutch and ball-bearing sheave combinations, pre-engineered and aligned, are presented in an attractive, color-illustrated brochure. For direct installation on standard electric motors from 1 to 25 hp. Package is known as Electro-Sheave.

Warner Electric Brake & Clutch Co., Beloit, Wis.

Circle number 116 on reader service card

Bearings and pillow blocks

Thirty-two-page catalog 100 covers the Unibal lines of ball and roller bearings, spherical bearings and rod ends, pillow blocks and flange units. Complete product specifications are given, along with engineering and use information and lubrication data. Well illustrated with clear diagrams and charts.

Heim Co., Fairfield, Conn.

Circle number 117 on reader service card

For more information on any components discussed in the feature or idea articles in this issue, fill out and mail blank below. This applies only to those articles referring to this page.

EDITOR, POWER TRANSMISSION DESIGN *JUNE, 1959*
812 HURON ROAD, CLEVELAND 15, OHIO

Please send me more information on components discussed in articles below. I am listing only one component per line.

(1) ..... (Component Name) on page ..... in Article No. .....

(2) ..... (Component Name) on page ..... in Article No. .....

(3) ..... (Component Name) on page ..... in Article No. .....

(4) ..... (Component Name) on page ..... in Article No. .....

NAME .....POSITION .....

FIRM .....TYPE BUSINESS .....

ADDRESS ..... STATE.....

cut on dotted lines

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EDITOR, POWER TRANSMISSION DESIGN *JUNE, 1959*
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BOOKS

Basic Engineering Mechanics and Machine Design

By S. S. Aidlin, P. E., consulting engineer. Published by Pelex Publishers, Inc., and available from Stephan Howard, 225 Stone Ave., Brooklyn 33, New York. Copyrighted 1952. *Price*: $3.50.

Presents a review of graphic methods of problem analysis involving forces, torques, and accelerations. It covers principles of mechanical design as well as the special design of mechanical elements found in machinery. Also included are charts and tables for calculating gear sizes. Featured are short cut methods which are especially useful to the machine designer.

Elements of Engineering Statics

By H. Deresiewicz. Published by the Columbia University Press, 2960 Broadway, New York 27, N. Y.; Price: $3.50.

Basic statics for all engineering students. A working knowledge of differential calculus and the concurrent study of integral calculus is needed. Techniques of vector algebra are used to rigorously develop the fundamental theorems, results, and methods of statics. Application of these to solution of engineering problems is also shown. Discussions of the equivalence of force systems, the principle of virtual work, and the concept of stability are offered.

Selected Bibliography on Precision Instrument and Fluid Bearings with Annotations

By J. G. Weir. Report PB 131791, *may be ordered from OTS, U. S. Dept. of Commerce, Washington* 25, *D. C.; 103 pages; Price*: $2.50.

Bibliography of 440 annotated references concerning the entire field of precision instrument ball bearings and fluid bearings, it has been compiled by the U. S. Naval Avionics Facility and released for sale through the Office of Technical Services.

The compilation is the result of an extensive survey of the industry as one phase of the Navy's bearing research program. References are grouped into categories dealing with design, selection; failures, causes; fluid bearings; jewel bearings; lubrication, lubricants; maintenance; manufacturing methods; materials; packaging, preservatives; testing, inspection. Indexes to corporate names and authors are included.

PRICE of ENGINEERING FORMULAS & TABLES is $4.75 not $9.50 as listed in the February issue.

BEARING MEASUREMENTS *continued from page 49*

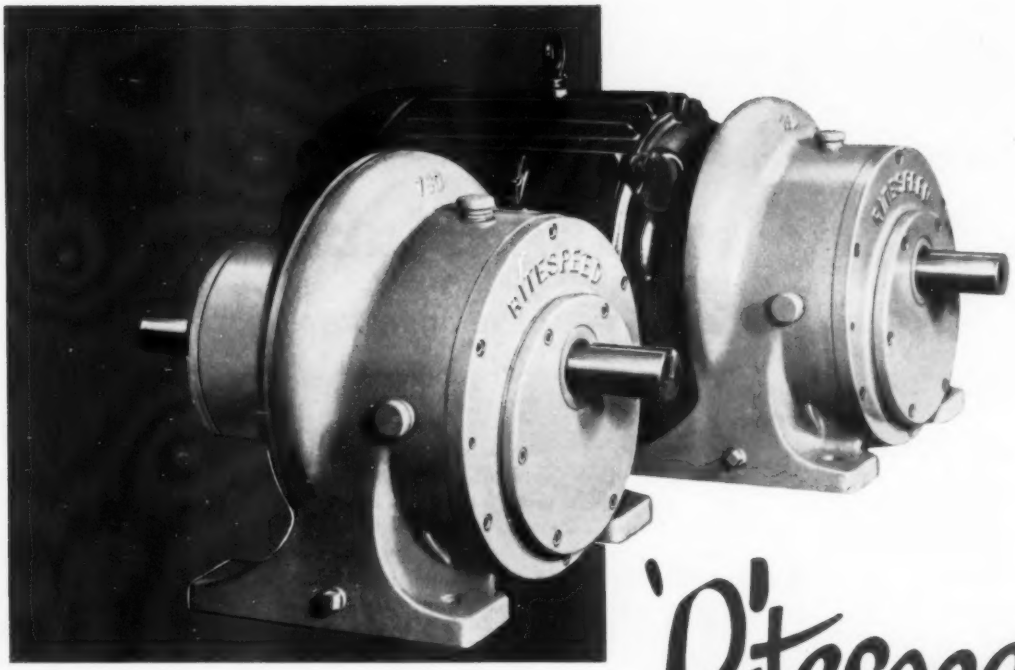
(preferably 0.0001 to 0.0002 in. on the diameter per inch of length) or use a true running weight, heavy enough to seat the balls in the races. Support the outer ring in horizontal position and apply a calibrated dial indicator to the side of the inner race. The deviation from groove parallelism with the side is the difference between the maximum and minimum readings when rotating the arbor one revolution. This applies to groove-type ball only.

How to check Outer Race

To check the OD, set bearing upright on a flat surface and use a calibrated dial indicator with a rounded point. If out-of-roundness and taper exist, a minimum diameter reading d_{min} and a maximum diameter reading d_{max} will show up. The outside diameter, d_m, is the average of the two readings. When measuring thin-section races, gaging pressure should be kept small to prevent distortion. Large diameter races with thin sections should be placed in a horizontal position.

To check race width, support the outer race on one side by three buttons. Let the inner race rotate. Apply calibrated indicator against opposite side directly over one button and take reading while

Continued on page 63



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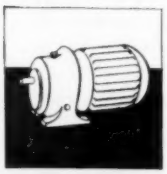

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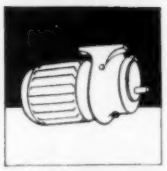

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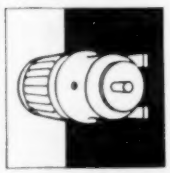

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ABSTRACTS *of current technical papers*

How to use solid film lubricants

at temperatures above 1000 F

BY RALPH E. CRUMP, chief engineer, Electrofilm Inc.

SOLID FILM LUBRICANTS can be used successfully on rubbing parts and bearings at temperatures of 1000 F and higher. No conventional liquid or grease lubricant is effective above 700 F. Jet engine thrust control devices, bleed air valves and variable-pitch turbine blades are just a few of the devices that work at these temperatures. To work successfully, they must be lubricated.

What's a Solid Film Lubricant?

As the name implies, it is a solid, fixed, thin film made up of solid lubricants held together and in place by a suitable binder. These films are usually less than 0.001 in. thick. For normal temperature applications, the most popular solid lubricants are molybdenum disulphide (MoS_2) and graphite. The binder which holds them together and to the part to be lubricated is thermoplastic resin when it is to be air dryed. Thermoplastic resin is used when heat curing is employed.

Above 800 F, MoS_2 cannot be used, with one exception, because it oxidizes to trioxide which is abrasive. The exception occurs when the film wears away faster than it oxidizes. Then it produces a low coefficient of friction and has good wear protection.

Material	Melting or oxidation point-F	Structure	Remarks
Aluminum Phosphate (Ortho)	2732	Hexagonal	
Boron Nitride	4860	Laminar	Tests to date neg.
Calcium Sulphate	2642	Rhombic	
Cadmium Sulphide	3182	Hexagonal	
Chromic Chloride	2102	Cubic	
Cuprous Sulphide	2012	Rhombic	
Lead Oxide	1634	Tetragonal	Low Coefficient of friction at high temp; presently commercial.
Lead Sulfate	1830	Hexagonal	
Indium Sulfide	1275		Several forms
Stannous Oxide	1292	Tetragonal	
Silicon Nitride	3452		
Silver Sulphide	1510	Cubic	
Titanium Carbide	5580	Cubic	
Titanium Disulphide	—	Laminar-Hexagonal	
Tungsten Disulphide	—	—	Tests to date neg.
Zinc Phosphate	1652	Rhombic	

Some clues to successful high-temperature solid film lubricants have come from knowledge of what seems to make others successful at lower temperatures. Typical of these desirable physical and chemical properties are: insolubility in water and cleaning solvents, latticed laminar layer, hardness, etc. A literature survey has yielded the list of possibilities in Table 1.

Lead Oxide-Graphite Lubricant

An NASA report points out that lead oxide (PbO) as well as several other metallic salts might be suitable high-temperature solid film lubricants. Testing showed that PbO has a low coefficient of friction at 1000 F, but a rather high one at room temperature, Figure 1a. Since any high-temperature lubricant must also perform at normal temperatures, some way had to be found to overcome this. Because graphite has the opposite characteristic, Figure 1b, it seemed that a mixture of the two should be good over a wide temperature range.

Although graphite and PbO can be mixed for dry lubrication, the problem of finding a binder to hold them together and to the part to be lubricated still remained. Resins, particularly the thermosetting ones, have a high-temperature limit of 600 to 700 F.

As possible binders, several glass-cermet-ceramic combinations were investigated. From these, a porcelain enamel was chosen. One of the virtues of this binder, an extremely important one, was its coefficient of thermal expansion. This must be consistent with that of the metal to be coated. Also, the binder should adhere to many metals, not just one. Several solvents were investigated, and water with a small amount of wetting agent added proved to be satisfactory for thinning the mixture to simplify application to the metal.

Before application of the lubricant, the metal surface

This article abstracted from a paper presented at the SAE Annual Meeting, Sheraton-Cadillac and Statler Hotels, Detroit, January 12-16, 1959.

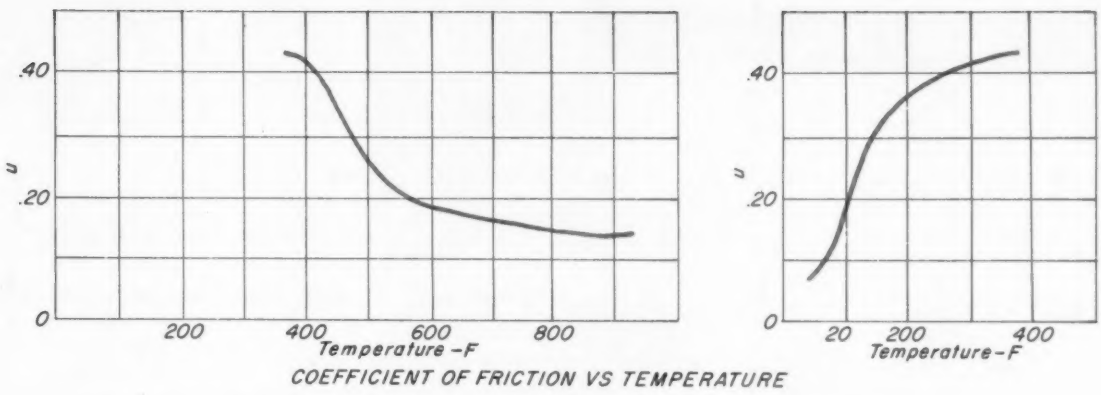

FIG. 1. COEFFICIENTS OF FRICTION for lead oxide, left, and graphite, right, versus temperature.

is prepared to insure cleanliness and good adhesion. Figure 2 shows typical preparation procedures. The light sand blast provides a surface with enough developed area to assure good adhesion. Coefficients of friction for various metal combinations using this lubricant are given in Table 2.

Friction and Wear

Friction at high temperatures follows the same pattern as at low temperatures. Friction force, F, is the product of the shear stress, S, of the softer material and the contact area, a, or

$$F = S \times a \quad \text{.....(1)}$$

A solid film lubricant between the two rubbing surfaces reduces the friction because of its low S value which is the result of the physical properties of the lubricant.

The area, A, in contact with a solid film lubricant depends on the film, the hardness, H, of the metal on which the film is applied, and the load, L.

$$A = \frac{L}{H} \quad \text{.....(2)}$$

Since the film is very thin—usually 0.0003 to 0.0005 in.—it must rely on the plastic and elastic stresses of the metal to which it is applied for support.

By substituting equations 1 and 2 in the equation for coefficient of friction, $\mu = F/L$, we get

$$\mu = \frac{S \times a}{H \times a} = \frac{S}{H} \quad \text{.....(3)}$$

At room temperature, coefficient of friction increases with decreasing metal hardness, and hardness of most metals decreases with increasing temperature. Therefore, coefficient of friction will increase with increasing temperature. Decreasing shear strength of the metal will have little effect since the solid film lubricant is separating the metals.

Archard's equation for predicting abrasive wear,

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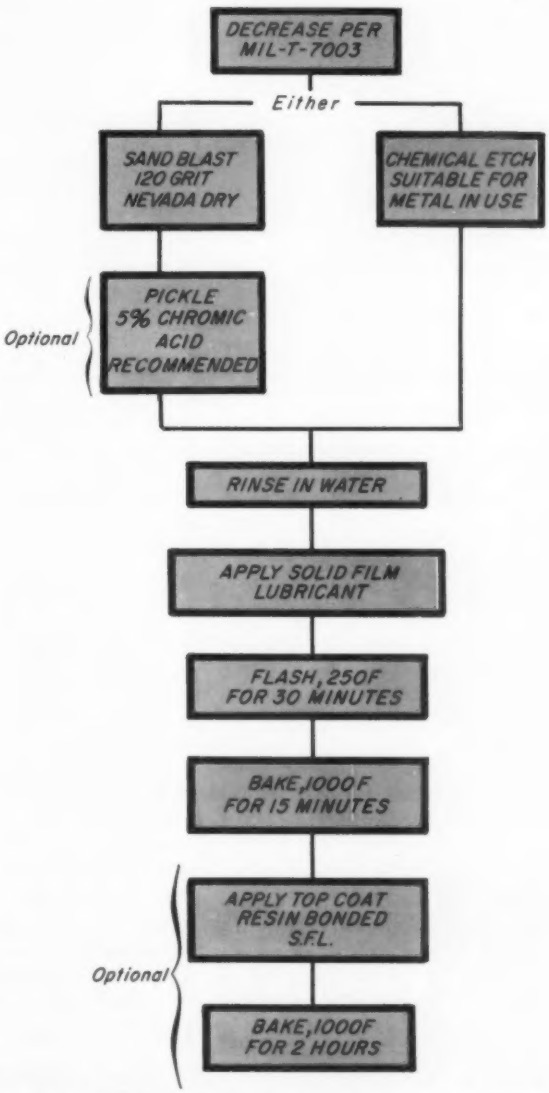


FIG. 2. SURFACE PREPARATION methods for metals to be coated with solid film lubricant.

ABSTRACT *continued from preceding page*

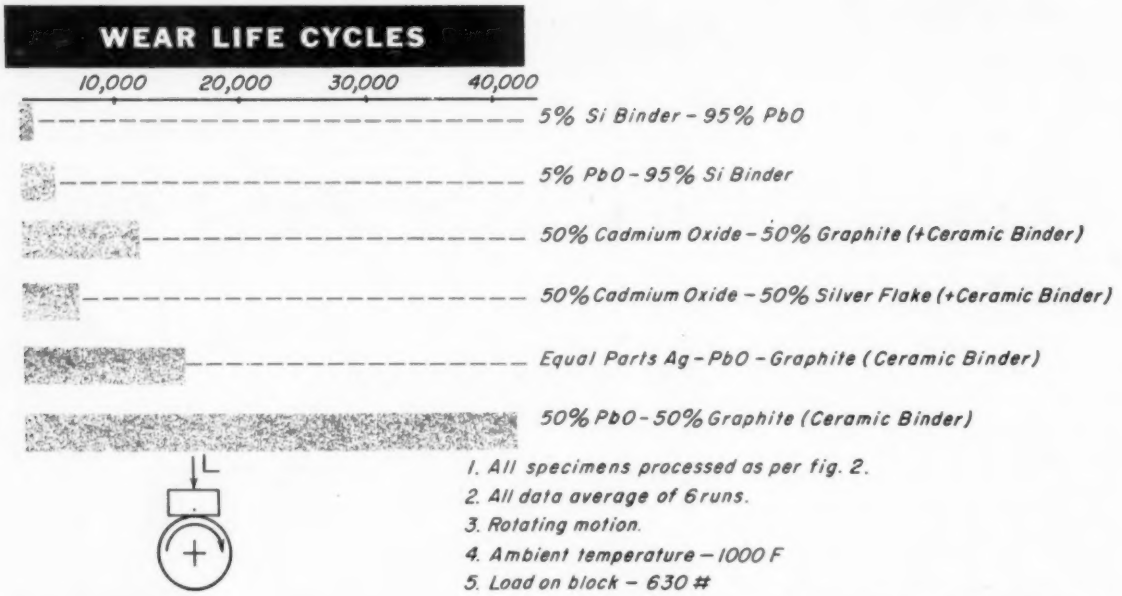
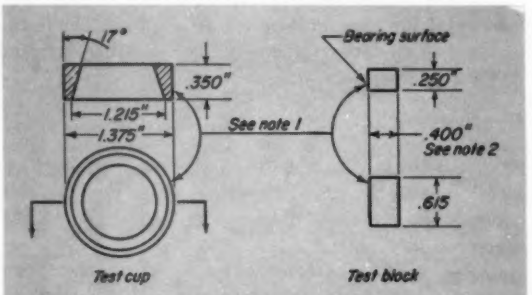


FIG. 3. (Above) PERFORMANCE COMPARISON of several solid film lubricants and binders at 1000 F.

FIG. 4. (Below) DIMENSIONS and surface finishes for high-temperature solid film lubricant test specimens.



NOTES. 1. Finish of surfaces indicated held to a smoothness of 5 to 10 microinches (RMS)
2. Surfaces determined by .400 in. dimension held to within .001 in. (TIR) of parallel
3. Concentricity of test cup OD to its tapered ID held within .0003 in. (TIR)

$$V = \frac{l \times L \times K \times C}{H} \quad \text{.....(4)}$$

where V = Volume of worn material, in.^{3}
l = Length of travel, in.
L = Load, lb
K = Probability constant
C = System constant, (depends on speed, film properties, coefficient of friction, etc.)

is applicable to wear with solid boundary lubricants. By rearranging equation 4 to this form,

$$\frac{V}{l} = \frac{L}{H} \times K \times C \quad \text{.....(5)}$$

the volume term is expressed as volume of worn material per unit length of travel. The L/H term is defined by equation 2 as the contact area, A. It and the wear rate will increase with increasing temperature since hardness, H, decreases with temperature.

Tests of wear rates with several ceramic-bonded solid film lubricants have been made. Results of some of these are shown in Figure 3. Tests were made using a flat block rubbing against the outer surface of the outer race of a tapered roller bearing. Specimens were prepared by the procedure outlined in Figure 2 to the dimensions indicated in Figure 4.

Test specimens run in an electrically-heated oven. Friction measurements are made using a calibrated cantilever against which the block bears. Deflection of the cantilever due to friction force against the block is measured by strain gages.

Further work will undoubtedly yield better high-temperature solid lubricants and binders to work at even higher temperatures.

TABLE 2 - FRICTION COEFFICIENT WITH SOLID FILM LUBRICANTS

Specimen	Block (bare)	Coated μ at 75 F	Coated μ at 750 F	Coated μ at 1000 F	Uncoated
Hastelloy C	Hastelloy C	.320	.320	.320	.540
Hastelloy C	Ni resist IIA	.280	.330	.360	.440
Hastelloy C	Aisi 440 C	.380	.340	.320	.490
Stellite 6	Aisi 440 C	.250	.430	.420	.470
17-4 PH	Greek Ascalloy	.250	.290	.350	.670
17-4 PH	Stellite 31	.280	.300	.390	.670
Steel	Inconel X	.119	—	.177	.360
75 A Titanium	75 A Titanium	.160	.080 at 850	.080 at 1100	—
A 286	Aisi 440 C	—	—	.090 at 1100	—
Aisi 440 C	SS 410	—	—	.090 at 1100	—

continued from page 58

rotating the race. Width tolerances apply to one race at a time and not to the total bearing width.

To check parallelism of sides, support the outer race on one side by three buttons. Let the inner race rotate. Apply calibrated dial indicator against opposite side directly over one button and take reading while rotating the race. Deviation from parallelism of the sides is the difference between the largest and smallest width.

To check radial runout, mount the bearing on an arbor having a very slight taper (0.0001 to 0.0002 in. on diameter per inch of length). Apply calibrated dial indicator on center of outer ring. Radial runout is the difference between the minimum and maximum reading when rotating outer ring one revolution with arbor stationary.

To check groove parallelism with side, mount the bearing on an arbor having a very slight taper (preferably 0.0001 to 0.0002 in. on the diameter per inch of length). Apply a true running weight to the outer ring, or use a true weight heavy enough to seat the balls on the races. Support the arbor in a vertical position and apply the calibrated indicator to the side of the outer race. Deviation from groove parallelism with the side is the difference between the maximum and minimum reading when rotating outer ring one revolution. This applies only to groove-type ball.

To check OD squareness with side, support one side of the outer race on a flat plate with inner ring free. Fix the race against a stop located close to the lower corner of the OD. Apply a calibrated dial indicator directly above the stop, close to the upper corner of the OD. Deviation from OD squareness with the side is the difference between the minimum and the maximum readings when rotating the outer race one revolution. This method applies to bearing width series 1, or narrower.

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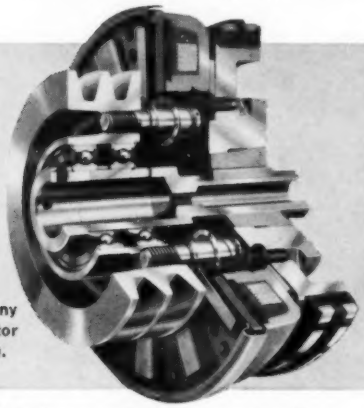

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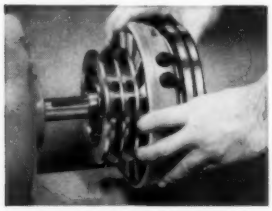
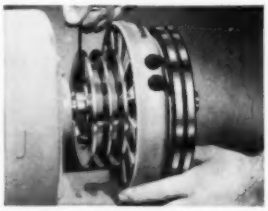
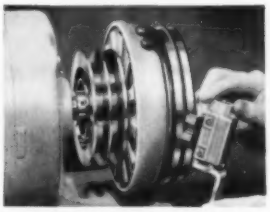


1—Packaged clutch-and-sheave assembly mounts easily to any standard NEMA motor shaft. No machining or alignment necessary.



2—With clutch-sheave package in place, setscrews secure the built-in shaft extension, which transmits motor rotation to the clutch magnet.



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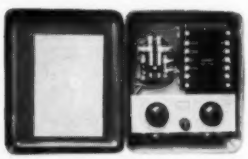

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